

# Inter-American Metrology System - SIM

# INSTITUTO NACIONAL DE METROLOGIA, QUALIDADE E TECNOLOGIA – INMETRO

# FINAL REPORT ON SUPPLEMENTARY REGIONAL COMPARISON SIM.AUV.A-S2: CALIBRATION OF PISTONPHONE

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#### ABSTRACT

This document is the Final Report of the Inter-American Metrology System supplementary comparison on pistonphone calibration SIM.AUV.A-S2 that took place between September 2018 and January 2020. Seven national metrology institutes participated on this comparison: CENAM/Mexico, INACAL/Peru, INMETRO/Brazil, INTI/Argentina, LACOMET/Costa Rica, NIST/USA and NRC/Canada. INMETRO was the pilot institute responsible for the coordination of this comparison. One pistonphone was circulated among the participants to carry out calibrations according to the international standard IEC 60942:2017 using both LS1P and LS2P measurement microphones. Beyond the mandatory measurement of the sound pressure level, it was requested to the participants report measurement results of frequency, total harmonic distortion and total distortion + noise (measured over a bandwidth of 22.4 Hz to 22.4 kHz) for the purpose of investigation. For sound pressure level and frequency measurement results, supplementary comparison reference values (SCRVs) were determined using the weighted mean method and the corresponding degrees of equivalence between each participant and the SCRV are presented. All participants presented consistent results. For total harmonic distortion and total distortion + noise measurements, SCRVs were not calculated and the values reported by participants are compared with the calculated arithmetic mean and weighted mean values. Overall, the supplementary comparison SIM.AUV.A-S2 was considered successful and fit its purpose.

# CONTENT

1	INTRODUCTION		4
2	COMPARISON PROTOCOL		4
3	3 PARTICIPANTS AND TIMETABLE		4
	3.1	Participants	4
	3.2	Timetable	5
4	TRAVE	LING PISTONPHONE	6
	4.1	Pistonphone	6
	4.2	Stability check	6
5	STATIS	STICAL CRITERIA FOR PERFORMANCE ASSESSMENT	10
6	REPOR	RTED RESULTS	11
7	STATIS	STICAL EVALUATION OF INSTITUTES' PERFORMANCE	19
	7.1	Supplementary comparison reference values for sound	
		pressure level and frequency	19
	7.2	Degrees of equivalence for sound pressure level and frequency	20
	7.3	Mean values calculated for total harmonic distortion and total	
		distortion + noise	23
	7.4	Measured total harmonic distortion, total distortion + noise	
		and the calculated mean values	24
8	COMMENTS		26
9	ACKNOWLEDGEMENTS		27
10	) REFERENCES		27
APPENDIX A – RESULTS SUBMITED BY INACAL		29	
APPE	APPENDIX B – REPORTED SPREADSHEET TEMPLATES		30
APPEN	PENDIX C – UNCERTAINTY BUDGETS		46
APPENDIX D – LACOMET COMMENTS ON THE UNCERTAINTY REPORTED FOR			
SOUND PRESSURE LEVEL			63

### **1 INTRODUCTION**

The supplementary comparison SIM.AUV.A-S2 is the second comparison on pistonphone calibration carried out under the auspices of the Inter-American Metrology System (SIM). Seven national metrology institutes (NMIs), all belonging to the SIM, participated on this comparison and one pistonphone was circulated between them. Each participant used its own technical procedure in addition to the agreed technical protocol. This report presents the history relative to the technical protocol approval, lists the participating institutes, details the traveling pistonphone, describes the statistical criteria for performance assessment, presents the results reported by the participants, evaluates statistically the institutes' performance, and provides comments on the results obtained.

# 2 COMPARISON PROTOCOL

On April 2018, a first proposal of technical protocol on pistonphone calibration was prepared by the pilot institute and circulated between the members of SIM Metrology Working Group (MWG-9) for comments. Shortly after this, a revised version was circulated for approval. After the approval by the MWG-9 members, on May 2018, it was submitted to the Key Comparison Working Group (KCWG) of the Consultative Committee for Acoustics, Ultrasound and Vibration (CCAUV) for review. The final technical protocol [1] was approved by the KCWG on August 2018, and it was published together with the supplementary comparison registration and progress form on the Key Comparison Data Base (KCDB) of the *Bureau International des Poids et Mesures* (BIPM). Two supplements were issued later. The first one, issued on April 2019, changed the order of participation between two NMIs and introduced a little shift on the timetable. This was done to take advantage of a technical meeting to transfer the pistonphone by hand from one participant to another one. All involved NMIs were consulted and agreed with this schedule adjustment. The second one, issued on July 2019, introduced another shift on the timetable due to the pistonphone retention in customs.

## **3 PARTICIPANTS AND TIMETABLE**

## 3.1 Participants

The participating NMIs were: Centro Nacional de Metrología (CENAM, from Mexico); Instituto Nacional de Calidad (INACAL, from Peru); Instituto Nacional de Metrologia, Qualidade e Tecnologia (INMETRO, from Brazil); Instituto Nacional de Tecnología Industrial (INTI, from Argentina); Laboratorio Costarricense de Metrologia (LACOMET, from Costa Rica); National Institute of Standards and Technology (NIST, from USA); and National Research Council Canada (NRC, from Canada). The role of pilot institute was undertaken by INMETRO.

## 3.2 Timetable

Measurements took place between September 2018 and January 2020. The time schedule was organized considering the circulation of the pistonphone in a ring configuration, with an intermediate stability check by the pilot institute. The sequence of participants was chosen in order to optimize the transportation of the pistonphone between them. The actually performed measurement and circulation timetable of the pistonphone is presented in Table 1.

National Metrology Institute	Period for measurements	
INMETRO	September 24 <sup>th</sup> to October 5 <sup>th</sup> , 2018	
Transportation of the pistonpho	ne by previous NMI to the next one	
NRC	October 22 <sup>nd</sup> to November 2 <sup>nd</sup> , 2018	
Transportation of the pistonpho	ne by previous NMI to the next one	
NIST	November 19 <sup>th</sup> to 30 <sup>th</sup> , 2018	
Transportation of the pistonpho	ne by previous NMI to the next one	
CENAM	December 17 <sup>th</sup> , 2018 to January 11 <sup>th</sup> , 2019	
Transportation of the pistonpho	ne by previous NMI to the next one	
INMETRO	INMETRO January 28 <sup>th</sup> to February 8 <sup>th</sup> , 2019	
Transportation of the pistonphone by previous NMI to the next one		
INTI	INTI February 25 <sup>th</sup> to March 15 <sup>th</sup> , 2019	
Transportation of the pistonphone by previous NMI to the next one		
LACOMET	April 8 <sup>th</sup> to 19 <sup>th</sup> , 2019	
Transportation of the pistonphone by previous NMI to the next one		
INACAL	July 18 <sup>th</sup> to August 26 <sup>th</sup> , 2019	
INACAL	October 14 <sup>th</sup> to 22 <sup>nd</sup> , 2019	
Transportation of the pistonpho	ne by previous NMI to the next one	
INMETRO	December 2 <sup>nd</sup> , 2019 to January 2 <sup>nd</sup> , 2020	

Table 1 – Measurement and circulation timetable of the pistonphone.

INMETRO carried out measurements in three periods during the pistonphone circulation, but only the results obtained during the first period were used for comparison with the supplementary comparison reference value (SCRV). The results obtained during the second and third periods were used only to check the pistonphone's stability.

INACAL carried out measurements in two periods during the pistonphone circulation. The first one, before a request from the pilot institute to check and confirm its results (more details in item 6). The second one was after this request. Only the results obtained during the second period were used for comparison with the SCRV. It should be noted that the pilot institute was not consulted by INACAL about its desire to make new measurements and only became aware of this when analyzing the revised documentation submitted after the request for check and confirmation of its data. These new measurements were possible because INACAL had difficulties to return of the pistonphone to INMETRO and it was kept for a longer period than initially expected. As the SCRV had not been disclosed, the coordination of this comparison understood

that there was no problem in using the results obtained during the second period, since this occurrence was registered.

# **4 TRAVELING PISTONPHONE**

# 4.1 Pistonphone

The artefact circulated among the institutes was one pistonphone manufactured by Brüel and Kjaer, type 4228 [2] and serial number 2836183, with its one-inch to half-inch adaptor type DP 0776 (for coupling of LS2P measurement microphones) and its user manual.

Each participant had to calibrate the pistonphone using the microphone method (insert voltage technique) and report the generated sound pressure level. Reports of frequency, total harmonic distortion and total distortion + noise (measured over a bandwidth of 22.4 Hz to 22.4 kHz) of the sound pressure level generated by the pistonphone were also suggested for the purpose of investigation. Total harmonic distortion is defined as the ratio of the root-mean-square (rms) value of the harmonic content to the rms value of the fundamental component or the reference fundamental component of an alternating quantity [3]. On the other side, total distortion + noise is the ratio of the rms of the total distortion and noise components, including any harmonics and sub-harmonics, to the rms of the entire signal [4].

All measurements were to be performed using both a LS2P and a LS1P measurement microphone. In the case of a participant being able to perform measurements with only one type of microphone, then the report of results should clearly state which type of microphone was used. The pistonphone circulated between the participants is owned by INMETRO, who kindly supplied it for this project.

# 4.2 Stability check

INMETRO checked the pistonphone's stability before the beginning of circulation, during the comparison and after the end of circulation. This checking consisted of pistonphone calibrations by the microphone method using the insert voltage technique in order to obtain the generated sound pressure level, frequency, total harmonic distortion and total distortion + noise (measured over a bandwidth of 22.4 Hz to 22.4 kHz). All stability measurements were performed using a LS2P and a LS1P measurement microphone. Figures 1 to 8 show the differences of measured values at each check calibration with respected to their common average. No significant trend was observed, although notable variances in the measured values of total harmonic distortion and total distortion + noise, with respect to the reported measurement uncertainty, were observed.



Figure 1 – Differences of the sound pressure levels measured using a LS2P microphone at each check calibration with respect to their common average. Uncertainty bounds are shown.



Figure 2 – Differences of the sound pressure levels measured using a LS1P microphone at each check calibration with respect to their common average. Uncertainty bounds are shown.



Figure 3 – Differences of the frequencies measured using a LS2P microphone at each check calibration with respect to their common average. Uncertainty bounds are shown.



Figure 4 – Differences of the frequencies measured using a LS1P microphone at each check calibration with respect to their common average. Uncertainty bounds are shown.



Figure 5 – Differences of total harmonic distortion measured using a LS2P microphone at each check calibration with respect to their common average. Uncertainty bounds are shown.



Figure 6 – Differences of total harmonic distortion measured using a LS1P microphone at each check calibration with respect to their common average. Uncertainty bounds are shown.



Figure 7 – Differences of total distortion + noise measured using a LS2P microphone at each check calibration with respect to their common average. Uncertainty bounds are shown.



Figure 8 – Differences of total distortion + noise measured using a LS1P microphone at each check calibration with respect to their common average. Uncertainty bounds are shown.

### **5 STATISTICAL CRITERIA FOR PERFORMANCE ASSESSMENT**

Performance assessment was made using the Procedure A presented by M. G. Cox in the paper "The Evaluation of Key Comparison Data" [5] and the Procedure Full

Enumeration also shown by M. G. Cox in the paper "The Evaluation of Key Comparison Data: Determining the Largest Consistent Subset" [6].

In summary, the weighted mean (using the standard uncertainty as weighting factor) and its standard deviation are determined. Then, the chi-squared test (with a probability of 5 %) is applied to carry out an overall consistency check of the measurement results. When the consistency does not fail, the weighted mean is accepted as the SCRV, its standard deviation is accepted as the standard uncertainty and the degrees of equivalence are calculated. When the consistency check fails, anomalous measurement results are identified (comparing the differences between the results and the weighted mean with the uncertainties of those differences) and the corresponding institutes are invited to check their results for any numerical errors. If no numerical error is found, then a new weighted mean and its standard deviation are determined after removing the most anomalous measurement result and the process is re-started. On the other side, if a numerical error is found, a new weighted mean and its standard deviation are determined deviation are determined considering the new value and the process is re-started.

## 6 REPORTED RESULTS

The participants were requested to report their results using a spreadsheet template previously sent by the pilot institute. The value of the measurand was to be presented with one extra decimal figure than its respective uncertainty. The pilot institute rounded the results of each participant to the same number of decimal figures of the reported uncertainty. In addition to the template, a formal calibration certificate usually issued by the participant and an uncertainty budget were requested.

The results reported by each participant were analyzed according to item 5. An anomalous measurement result was identified in the submitted results of INACAL for sound pressure level measured using a LS2P microphone. In accordance with the CIPM MRA guidelines [7], INACAL was invited to check its results. It was informed on the parameter of the anomalous measurements results (for example, sound pressure level), but it was not informed about the type of microphone associated to the data (for example, LS2P measurement microphone).

INACAL carried out new measurements, which were possible due to difficulties to return the pistonphone to INMETRO and it was kept for a longer period in Peru than initially expected (see subitem 3.2 for more details). Therefore, INACAL reviewed its results and submitted new values for all measured parameters, i.e. results for sound pressure level, frequency and total harmonic distortion measured using a LS2P microphone. The new set of results were analyzed again and no anomalous measurement results was identified. The first and the revised sets of results submitted by INACAL are summarized in Appendix A. The two full spreadsheets reported by INACAL are presented in Appendix B. The final reported results are shown in Figures 9 to 16 and Tables 2 to 9. Participants are presented according to the order of their participation. The spreadsheet templates filled by each participant are presented in Appendix B and uncertainty budgets for sound pressure level measurements sent by each participant are presented in Appendix C. The report of sound pressure level measurement was mandatory, while reports of frequency, total harmonic distortion and total distortion + noise measurements were just suggested for the purpose of investigation.



Figure 9 – Results reported by participants: Sound pressure level (corrected for load volume and for the reference environmental conditions) measured using a LS2P microphone.

Table 2 – Results reported by participants: Sound pressure level (corrected for load volume and for the reference environmental conditions) measured using a LS2P microphone.

NMI	Measured SPL [dB (reference: 20 μPa)]	Expanded Uncertainty 95 %, k = 2 [dB (reference: 20 μPa)]
INMETRO	123.95	0.07
NRC	123.97	0.07
NIST	123.93	0.07
CENAM	123.90ª	0.08ª
INTI	123.97	0.08
LACOMET	123.89	0.06
INACAL	123.95 <sup>b,c</sup>	0.12 <sup>b,c,d</sup>

Notes:

<sup>a</sup> The SPL was measured by the "direct measurement" method. Despite of the technical protocol [1] stating that it should be measured by the microphone method (insert voltage technique), the measurement result was considered for comparison purposes. <sup>b</sup> The SPL was measured by the sound calibrator comparison method. Despite of the technical protocol [1] stating that it should be measured by the microphone method (insert voltage technique), the measurement result was considered for comparison purposes.

<sup>c</sup> Revised value.

<sup>d</sup> Despite of the uncertainty of measurement exceeding the maximum-permitted value (± 0.10 dB) stated in IEC 60942:2017 [4], the measurement result was considered for comparison purposes.



Figure 10 – Results reported by participants: Sound pressure level (corrected for load volume and for the reference environmental conditions) measured using a LS1P microphone.

Table 3 – Results reported by participants: Sound pressure level (corrected for load volume and for the reference environmental conditions) measured using a LS1P microphone.

NMI	Measured SPL [dB (reference: 20 μPa)]	Expanded Uncertainty 95 % <i>, k</i> = 2 [dB (reference: 20 μPa)]
INMETRO	123.96	0.07
NRC	123.98	0.08
NIST	123.95	0.09
CENAM	123.92ª	0.06ª
INTI	123.92	0.07
LACOMET	123.90	0.17 <sup>b</sup>
INACAL	Not reported	Not reported

Notes:

<sup>a</sup> The SPL was measured by the "direct measurement" method. Despite of the technical protocol [1] stating that it should be measured by the microphone method (insert voltage technique), the measurement result was considered for comparison purposes. <sup>b</sup> Despite of the uncertainty of measurement exceeding the maximum-permitted value (± 0.10 dB) stated in IEC 60942:2017 [4], the measurement result was considered for comparison purposes. (See Appendix D, for LACOMET comments).





Table 4 – Results reported by participants: Frequency measured using a LS2P microphone.

NMI	Measured Frequency [Hz]	Expanded Uncertainty 95 %, <i>k</i> = 2 [Hz]
INMETRO	251.2	0.1
NRC	251.2	0.2
NIST	251.17	0.12
CENAM	251.17	0.01
INTI	251.2	0.1
LACOMET	251.17	0.03
INACAL	251.17ª	0.01ª

<sup>a</sup> Revised value.



Figure 12 – Results reported by participants: Frequency measured using a LS1P microphone.

Table 5 – Results reported by participants: Frequency measured using a LS1P microphone.

NMI	Measured Frequency [Hz]	Expanded Uncertainty 95 %, k = 2 [Hz]
	[=]	55 /6) X = [1:2]
INMETRO	251.2	0.1
NRC	251.2	0.2
NIST	251.17	0.12
CENAM	251.17	0.01
INTI	251.2	0.1
LACOMET	251.17	0.03
INACAL	Not reported	Not reported





Table 6 – Results reported by participants: Total harmonic distortion measured using	g a
LS2P microphone.	

NMI	Measured THD [%]	Expanded Uncertainty 95 %, <i>k</i> = 2 [%]
	0.30	0.18
	0.0	0.15
NRC	0.9	0.5
NIST	0.34	0.12
CENAM	0.41	0.06
INTI	0.85	0.50
LACOMET	0.58	0.24
INACAL	0.23 <sup>a</sup>	0.03ª

<sup>a</sup> Revised value.



Figure 14 – Results reported by participants: Total harmonic distortion measured using a LS1P microphone.

Table 7 – Results reported by participants: Total harmonic distortion measured usir	ng a
LS1P microphone.	

NMI	Measured THD [%]	Expanded Uncertainty 95 %, <i>k</i> = 2 [%]
INMETRO	0.31	0.18
NRC	0.4	0.2
NIST	0.34	0.14
CENAM	0.39	0.06
INTI	0.42	0.50
LACOMET	0.38	0.23
INACAL	Not reported	Not reported





Table 8 – Results reported by participants: Total distortion + noise measured using a
LS2P microphone.

NMI	Measured TD + N [%]	Expanded Uncertainty 95 %, <i>k</i> = 2 [%]
INMETRO	1.30	0.30
NRC	1.4	0.4
NIST	0.88ª	0.14ª
CENAM	1.15	0.05
INTI	Not reported	Not reported
LACOMET	0.96	0.36
INACAL	Not reported	Not reported

<sup>a</sup> Revised value.





Table 9 – Results reported by participants: Total distortion + noise measured using a LS1P microphone.

NMI	Measured TD + N	Expanded Uncertainty 95 % k = 2 [%]
	[/8]	33 %, K = 2 [%]
INMETRO	0.68	0.30
NRC	0.7	0.3
NIST	0.82ª	0.21ª
CENAM	0.76	0.06
INTI	Not reported	Not reported
LACOMET	0.71	0.35
INACAL	Not reported	Not reported

<sup>a</sup> Revised value.

### **7 STATISTICAL EVALUATION OF INSTITUTES' PERFORMANCE**

# **7.1** Supplementary comparison reference values for sound pressure level and frequency

Tables 10 and 11 show the SCRVs for measurements using a LS2P and a LS1P microphone respectively. The results reported by all participants were used to calculate them. No correlations between the participants were accounted for in the following analysis.

	Measurand	Expanded Uncertainty 95 %, <i>k</i> = 2
SPL [dB (reference: 20 μPa)]	123.93	0.03
Frequency [Hz]	251.17	0.01

Table 10 – SCRV for measurements using a LS2P microphone.

	Measurand	Expanded Uncertainty 95 %, k = 2
SPL [dB (reference: 20 µPa)]	123.94	0.03
Frequency [Hz]	251.17	0.01

Table 11 – SCRV for measurements using a LS1P microphone.

### 7.2 Degrees of equivalence for sound pressure level and frequency

According to the CIPM MRA guidelines [7] it is not a requirement to report the degrees of equivalence (DoE) for a supplementary comparison. However, the DoEs have been calculated and reported with its expanded uncertainty, U(DoE). Figures 17 to 20 and Tables 12 to 15 show the DoEs and respective expanded uncertainty, U(DoE), for measurements using a LS2P and a LS1P microphone.



Figure 17 – Degrees of equivalence of the sound pressure level results measured using a LS2P microphone.

Table 12 – Degrees of equivalence of the sound pressure level results measured using	g
a LS2P microphone.	

NMI	DoE of Measured SPL [dB (reference: 20 μPa)]	Expanded Uncertainty 95 %, k = 2 [dB (reference: 20 μPa)]
INMETRO	0.02	0.06
NRC	0.04	0.06
NIST	0.00	0.06
CENAM	-0.03	0.07
INTI	0.04	0.07
LACOMET	-0.04	0.05
INACAL	0.02	0.12





Table 13 – Degrees of equivalence of the sound pressure level results measured using
a LS1P microphone.

NMI	DoE of Measured SPL [dB (reference: 20 μPa)]	Expanded Uncertainty 95 %, k = 2 [dB (reference: 20 μPa)]
INMETRO	0.02	0.06
NRC	0.04	0.07
NIST	0.01	0.08
CENAM	-0.02	0.05
INTI	-0.02	0.05
LACOMET	-0.04	0.17
INACAL	Not applicable	Not applicable



Figure 19 – Degrees of equivalence of the frequency results measured using a LS2P microphone.

Table 14 – Degrees of equivalence of the frequency results measured using a LS2P
microphone.

NMI	DoE of Measured	Expanded Uncertainty
	Frequency [Hz]	95 %, K = Z [HZ]
INMETRO	0.03	0.10
NRC	0.03	0.20
NIST	0.00	0.12
CENAM	0.00	0.01
INTI	0.03	0.10
LACOMET	0.00	0.03
INACAL	0.00	0.01



Figure 20 – Degrees of equivalence of the frequency results measured using a LS1P microphone.

microphone.		
NMI	DoE of Measured Frequency [Hz]	Expanded Uncertainty 95 %, k = 2 [Hz]
INMETRO	0.03	0.10
NRC	0.03	0.20
NIST	0.00	0.12
CENAM	0.00	0.01
INTI	0.03	0.10
LACOMET	0.00	0.03

Table 15 – Degrees of equivalence of the frequency results measured using a LS1P microphone.

### 7.3 Mean values calculated for total harmonic distortion and total distortion + noise

Not applicable

Not applicable

INACAL

Tables 16 and 17 show the arithmetic mean value (AM), the weighting mean value using all data (WM) and the weighting mean value using the largest consistent subset (WM – LCS) for measurements using a LS2P and a LS1P microphone respectively. The weighted means were calculated using the standard uncertainty as weighting factor and the largest consistent subset were calculated excluding the discrepant values, according to the procedure presented by Cox [6].

	0
	Measurand [%]
THD (AM)	0.52
THD (WM)	0.28
THD (WM – LCS)	0.40ª
TD + N (AM)	1.14
TD + N (WM)	1.12
TD + N (WM – LCS)	1.15 <sup>b</sup>

Table 16 – Mean values calculated for total harmonic distortion and total distortion + noise measurements using a LS2P microphone.

<sup>a</sup> LCS contains data reported by: CENAM, INMETRO, INTI, LACOMET and NIST.

<sup>b</sup> LCS contains data reported by: CENAM, INMETRO, LACOMET and NRC.

Table 17 – Mean values calculated for total harmonic distortion and total distortion + noise measurements using a LS1P microphone.

	•
	Measurand [%]
THD (AM)	0.37
THD (WM)	0.38
THD (WM – LCS)	Not applicable <sup>a</sup>
TD + N (AM)	0.73
TD + N (WM)	0.76
TD + N (WM – LCS)	Not applicable <sup>a</sup>

Note:

<sup>a</sup> All data are consistent.

# 7.4 Measured total harmonic distortion, total distortion + noise and the calculated mean values

Figures 21 to 24 show the measured total harmonic distortion, total distortion + noise (with expanded uncertainties) as reported by the participants and the calculated mean values for measurements using a LS2P and a LS1P microphone.



Figure 21 – Total harmonic distortion results reported by participants measured using a LS2P microphone. Solid line is the weighted mean value using the largest consistent subset (WM – LCS), dashed line is the arithmetic mean value (AM) and dotted line is the weighted mean value using all data (WM).



Figure 22 – Total harmonic distortion results reported by participants measured using a LS1P microphone. Dashed line is the arithmetic mean value (AM) and dotted line is the weighted mean value using all data (WM).



Figure 23 – Total distortion + noise results reported by participants measured using a LS2P microphone. Solid line is the weighted mean value using the largest consistent subset (WM – LCS), dashed line is the arithmetic mean value (AM) and dotted line is the weighted mean value using all data (WM).



Figure 24 – Total distortion + noise results reported by participants measured using a LS1P microphone. Dashed line is the arithmetic mean value (AM) and dotted line is the weighted mean value using all data (WM).

### **8 COMMENTS**

All participating NMIs presented consistent results for sound pressure level measurements and this comparison can be used to support their Calibration and Measurement Capabilities (CMCs). However, INACAL and LACOMET should expend efforts to improve their measurement uncertainties because the reported values exceed the maximum-permitted value stated in the international standard IEC 60942:2017. It

should be observed that INACAL reported measurement results obtained by the sound calibrator comparison method and CENAM, by the "direct measurement" method.

In addition, all participating NMIs also presented consistent results for frequency measurements.

Concerning the total harmonic distortion and total distortion + noise measurements, supplementary comparison reference values were not determined. This was decided due to the notable variances observed in the check calibrations carried out by the pilot institute, with respect to its reported measurement uncertainty. Another reason was a large difference between the uncertainties of measurement reported by the participants for these results. The distortion (total harmonic distortion and total distortion + noise) results reported by participants are presented together with different calculated mean values (arithmetic mean value, weighted mean value using all data and weighted mean value using the largest consistent subset) in order to allow comparison between the results. It should be noted that measurement of total harmonic distortion is not required by IEC 60942:2017 and it was requested in this comparison only for the purpose of investigation.

Overall, the supplementary comparison SIM.AUV.A-S2 was considered successful and fit its purpose: it allowed us to compare the sound pressure level and frequency measurements and to note the dispersion on the distortion (total harmonic distortion and total distortion + noise) measurements and on their estimated uncertainties.

## 9 ACKNOWLEDGEMENTS

The pilot institute hereby acknowledges and appreciates the dedicated time and efforts in contributing to this comparison by all the participating NMIs.

### **10 REFERENCES**

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### **APPENDIX A – RESULTS SUBMITED BY INACAL**

	Measured	Expanded Uncertainty 95 %, k = 2
SPL [dB (reference: 20 µPa)]	124.08	0.11
Frequency [Hz]	251.18	0.01
THD [%]	0.16	0.03

Table A.1 – First set of results submitted by INACAL measured using a LS2P microphone. Date of calibration: August 26<sup>th</sup>, 2019.

Table A.2 – Revised set of results submitted by INACAL measured using a LS2P microphone. Period of calibration: October 14<sup>th</sup> to 22<sup>nd</sup>, 2019.

	Measured	Expanded Uncertainty 95 %, <i>k</i> = 2
SPL [dB (reference: 20 µPa)]	123.95	0.12
Frequency [Hz]	251.17	0.01
THD [%]	0.23	0.03

# **APPENDIX B – REPORTED SPREADSHEET TEMPLATES**

### **B.1 INMETRO**

	stonphone manufactu	ired by Brüel and	Kjaer, type 4228, se	erial number 2836183, with its one-inch t	to half-inch adaptor type DP 0776
Resu	Its obtained with the	one-inch to half-i	nch adaptor type D	P 0776, i.e. using a half-inch reference r	measurement microphone
National Met	rology Institute	Inn	netro	]	
Period of t	he calibration	Airtempe	erature (°C)	Static pressure (kPa)	Relative humidity (%)
10 to12 of Se	eptember 2018	23,01	to 23,8	101,586 to 101,858	49,5 to 53,4
Sound pressure I	evel, dB re. 20 μPa (α	orrected for load v	volume correspond	ing to the microphone used and for the	e reference environmental conditions
	Determ	nined		Uncertai	nty (k = 2)
P.S.: The determin	123.9 ned SPL should be rep	orted with three o	decimals. The pilot	laboratory will round it for two decimal	.07 Is.
Frequ	ency, Hz	Total harmon	ic distortion, %	Total distortion + noise, % (measured	over a bandwidth of 22.4 Hz to 22.4 kH
Measured	Uncertainty (k = 2)	Measured	Uncertainty (k = 2	) Measured	Uncertainty (k = 2)
251.17	0.1	0.304	0.18	1.299	0.30
What was the orie down?	entation of the piston	phone during the	calibration? Was it	, horizontal? Was it vertical with the cavi	ity up? Was it vertical with the cavity
What was the orie down? It was vertical wit	entation of the piston h cavity up.	phone during the	calibration? Was it	horizontal? Was it vertical with the cavi	ity up? Was it vertical with the cavity
What was the orie down? It was vertical wit What was the met one?	entation of the piston; h cavity up. thod used to measure	phone during the	calibration? Was it und pressure leve	horizontal? Was it vertical with the cavi	ity up? Was it vertical with the cavity (insert voltage technique) or another
What was the orie down? It was vertical wit What was the mer one? The method used	entation of the piston h cavity up. thod used to measure was the microphone	phone during the the generated so method (insert vo	calibration? Was it und pressure leve pltage technique).	horizontal? Was it vertical with the cavi ? Did you use the microphone method (	ity up? Was it vertical with the cavity (insert voltage technique) or another
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	Artefac	t: Pistonphone m	anufactured by Brüe	el and Kjaer, type 4228, serial number 2	836183
		Results obtained	using an one-inch	reference measurement microphone	
National Met	rology Institute	Inn	netro	]	
Period of th	he calibration	Airtemp	erature (°C)	Static pressure (kPa)	Relative humidity (%)
10 to12 of Se	eptember 2018	23,3	to 23,9	101,660 to 101,902	51,1 to 56,9
Sound pressure l	evel dBre 20 uPa (o	orrected for load y	olume correspondi	ing to the microphone used and for the	reference environmental condition
Sound pressure in	Determ	nined	oranic correspond	Uncertai	nty (k = 2)
	123.9	955		0.	.07
P.S.: The determin	ned SPL should be rep	orted with three o	decimals. The pilot	laboratory will round it for two decimal	ls.
Frequ	ency, Hz	Total harmon	ic distortion, %	Total distortion + noise, % (measured	over a bandwidth of 22.4 Hz to 22.4 k
Measured	uncertainty (k = 2)	Measured	uncertainty (k = 2)	Measured	Uncertainty (k = 2)
		,			
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Are there any dev No, there are not.	iations from IEC 60942	2:2017 (Periodic te	sts) in the technica	I procedure used?	
Are there any dev No, there are not.	iations from IEC 60942	2:2017 (Periodic te	sts) in the technica	l procedure used?	
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Are there any dev No, there are not. What was the orie down?	iations from IEC 60942 entation of the piston	2:2017 (Periodic te	sts) in the technica calibration? Was it l	l procedure used? horizontal? Was it vertical with the cavi	ty up? Was it vertical with the cavity
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# B.2 NRC

-	stonphone manufactu	ired by Brüel and H	(jaer, type 4228, seria	I number 2836183, with its one-inch	to half-inch adaptor type DP 0776
Resu	Its obtained with the	one-inch to half-ir	ich adaptor type DP 0	776, i.e. using a half-inch reference	measurement microphone
National Me	trology Institute	National Research	Council of Canada		
Period of t 10/2	he calibration 22/2018	Air tempe 23	rature (°C) .32	Static pressure (kPa) 100.660	Relative humidity (%) 22.69
					1
Sound prossure	lovel dP ro 20 uPa (o	procted for load w	olumo correspondin	to the microphone used and for the	reference environmental condition
Sound pressure	Detern	nined	orume corresponding	Uncertai	inty (k = 2)
	123.9	971		0	.07
P.S.: The determi	ned SPL should be rep	orted with three o	lecimals. The pilot la	boratory will round it for two decima	ls.
Frequ	iency, Hz	Total harmoni	c distortion. %	otal distortion + noise, % (measured	over a bandwidth of 22.4 Hz to 22.4 kl
Measured	Uncertainty (k = 2)	Measured	Uncertainty $(k = 2)$	Measured	Uncertainty (k = 2)
251.17	0.2	0.87	0.3	1.40	0.4
P.S.: The measure	ed frequency, THD and	TD+N should be r	eported with one de	imal extra than their respective unce	ertainty. The pilot laboratory will rou
What was the me	thod used to measure	the generated so	und pressure level? [		
one? Microphone meth What was the refi LS2P (B&K Type 4	nod (insert voltage teo erence measurement 180)	hnique). microphone's type	e use? Did you used a	LS2P or another one?	(insert voltage technique) or another
what was the me Microphone meth What was the ref LS2P (B&K Type 4 What was the val	nod (insert voltage teo erence measurement 180) ue of the correction ar	hnique). microphone's type	e use? Did you used a	LS2P or another one?	(insert voltage technique) or another
Microphone meth What was the ref LS2P (B&K Type 4 What was the val a) for load volum	nod (insert voltage teo erence measurement 180) ue of the correction ap e corresponding to the	hnique). microphone's type oplied to the meas e used microphone	e use? Did you used a ured sound pressure s?	LS2P or another one?	(insert voltage technique) or another
Microphone meth Microphone meth Usar What was the ref LS2P (B&K Type 4 What was the val a) for load volum The load volume	nod (insert voltage teo erence measurement 180) ue of the correction ag e corresponding to the correction applied is -	hnique). microphone's type oplied to the meas e used microphone 0.08 dB.	e use? Did you used a ured sound pressure ??	LS2P or another one?	(insert voltage technique) or another
What was the ref Microphone meth What was the ref LS2P (B&K Type 4 What was the val a) for load volum The load volume b) for the referen	nod (insert voltage tec erence measurement 180) ue of the correction ag e corresponding to the correction applied is - ice environmental con	hnique). microphone's type oplied to the meas e used microphone 0.08 dB. ditions?	use? Did you used a ured sound pressure ??	LS2P or another one?	(insert voltage technique) or another
What was the ref Microphone meth What was the ref LS2P (B&K Type 4 What was the val a) for load volum The load volume b) for the referen The correction fo	nod (insert voltage tec erence measurement 180) ue of the correction ap e corresponding to the correction applied is - ice environmental condi	hnique). microphone's type oplied to the meas e used microphone 0.08 dB. ditions? tions for the pisto	use? Did you used a ured sound pressure ?? nphone is +0.054474	LS2P or another one?	(insert voltage technique) or another
What was the ref Microphone meth What was the ref LS2P (B&K Type 4 What was the val a) for load volum The load volume b) for the referen The correction fo What was the me	nod (insert voltage tec erence measurement 180) ue of the correction ag e corresponding to the correction applied is - ice environmental cond r environmental condi thod used to measure	hnique). microphone's type oplied to the meas used microphone 0.08 dB. ditions? tions for the pisto d the total distort	ured sound pressure ?? nphone is +0.054474 ion + noise? Did you	LS2P or another one? LS2P or another one? level: dB.	(insert voltage technique) or another
What was the ref LS2P (B&K Type 4 What was the val a) for load volume b) for the referen The correction fo What was the me The distortion me calculate the chos	nod (insert voltage tec erence measurement 180) ue of the correction ap e corresponding to the correction applied is - ice environmental condi- r environmental condi- thod used to measure easurement instrumers en distortion quantiti	hnique). microphone's type pplied to the meas used microphone 0.08 dB. ditions? tions for the pisto d the total distort at (Keithley 2015-P es.	e use? Did you used a ured sound pressure ?? nphone is +0.054474 ion + noise? Did you ) performs a FFT on t	LS2P or another one? LS2P or another one? level: dB. use a rejection filter device (distortion he signal and analyzes the levels of t	(insert voltage technique) or another n factor meter) or a FFT analyzer? he harmonics present in the signal to
What was the ref Microphone meth User (B&K Type 4) What was the val a) for load volume b) for the referen The load volume b) for the referen The distortion me calculate the chose Please, do not for uncertainty mea	nod (insert voltage tec erence measurement 180) ue of the correction ag e corresponding to the correction applied is - ice environmental condi thod used to measure easurement instrumer sen distortion quantiti rget to submit your fin surement" shall be us	hnique). microphone's type oplied to the meas e used microphone 0.08 dB. ditions? tions for the pisto d the total distort tt (Keithley 2015-P es. al uncertainty bud ed as the reference	e use? Did you used a ured sound pressure ?? nphone is +0.054474 on + noise? Did you ) performs a FFT on t get. The ISO docume e document.	LS2P or another one? LS2P or another one? level: dB. use a rejection filter device (distortion he signal and analyzes the levels of the ent "Evaluation of measurement data	(insert voltage technique) or another n factor meter) or a FFT analyzer? he harmonics present in the signal to - Guide to the expression of

	Artefa	ct: Pistonphone m	anufactured by Brüel an	d Kjaer, type 4228, serial number 2	336183
		Results obtained	d using an <mark>one-inch refe</mark> r	ence measurement microphone	
National Met	rology Institute	National Research	h Council of Canada		
Period of t	ne calibration	Airtemp	erature (°C)	Static pressure (kPa)	Relative humidity (%)
10/2	2/2018	23	3.22	100.689	29.75
Sound pressure I	evel. dB re. 20 uPa (c	orrected for load	volume corresponding to	the microphone used and for the	reference environmental condition
	Detern	nined		Uncertair	nty (k = 2)
	123.	983		0.	08
P.S.: The determin	ned SPL should be rep	orted with three	decimals. The pilot labo	ratory will round it for two decimal	5.
Frequ	ency, Hz	Total harmon	ic distortion. % Tota	al distortion + noise. % (measured o	over a bandwidth of 22.4 Hz to 22.4 k
Measured	Uncertainty (k = 2)	Measured	Uncertainty (k = 2)	Measured	Uncertainty (k = 2)
251.17	0.2	0.40	0.2	0.73	0.3
down? The pistonphone What was the met one? Microphone meth What was the refe	was oriented vertical hod used to measure od (insert voltage tec erence measurement	y with the cavity i the generated so chnique). microphone's typ	up. und pressure level? Did e used? Did you use a LS	you use the microphone method ( 1P or another one?	nsert voltage technique) or anothe
LS1P (B&K Type 41	.60)				
	e of the correction a	oplied to the mea	sured sound pressure le	vel:	
What was the value	e corresponding to the	2 used microphon 28 dB	er		
What was the value a) for load volume	correction used is -0.2	and the second s			
What was the value a) for load volume The load volume of b) for the reference	correction used is -0.2	ditions?			
What was the valu a) for load volume The load volume of b) for the referen The correction for	correction used is -0.2 ce environmental con environmental cond	nditions? itions for the pisto	onphone is +0.052674 dB		
What was the valu a) for load volume The load volume o b) for the referen The correction for What was the mel	correction used is -0.2 ce environmental con environmental cond hod used to measure	nditions? itions for the pisto d the total distort	onphone is +0.052674 dB tion + noise? Did you use	a rejection filter device (distortion	) factor meter) or a FFT analyzer?
What was the valu a) for load volume The load volume b) for the referen The correction for What was the met The distortion me calculate the chos	correction used is -0.2 ce environmental con environmental cond chod used to measure asurement instrumer en distortion quantit	nditions? itions for the pisto ed the total distort nt (Keithley 2015-F ies.	onphone is +0.052674 dB ion + noise? Did you use ?) performs a FFT on the	a rejection filter device (distortion signal and analyzes the levels of th	n factor meter) or a FFT analyzer? e harmonics present in the signal to
What was the value a) for load volume The load volume b) for the referen- The correction for What was the met The distortion me calculate the chos Please, do not for uncertainty measure	correction used is -0.2 ce environmental con environmental con chod used to measure asurement instrumer en distortion quantit get to submit your fir surement" shall be us	nditions? itions for the pisto ed the total distort nt (Keithley 2015-F ies. al uncertainty buo ed as the reference	onphone is +0.052674 dB (ion + noise? Did you use ?) performs a FFT on the dget. The ISO document ce document.	a rejection filter device (distortion signal and analyzes the levels of th "Evaluation of measurement data	n factor meter) or a FFT analyzer? e harmonics present in the signal to - Guide to the expression of

### **B.3 NIST**

Artefact: Pi	stonphone manufacti	ured by Brüel and	Kjaer, type 4228, seria	l number 2836183, with its one-inch	to half-inch adaptor type DP 0776
Resu	Its obtained with the	one-inch to half-	inch adaptor type DP 0	776, i.e. using a half-inch reference i	measurement microphone
National Met	rology Institute	NIS	ST (US)		
Period of t	he calibration	Airtemp	erature (°C)	Static pressure (kPa)	Relative humidity (%)
11/8	3/2018	2	23.3	100.92	32
Council and and a					
sound pressure i	Detern	nined	volume corresponding	g to the microphone used and for the Uncertai	inty (k = 2)
	123.	931		0.0	07 dB
P.S.: The determin	ned SPL should be rep	ported with three	decimals. The pilot la	poratory will round it for two decimal	ls.
Frequ	ency, Hz	Total harmor	nic distortion, % T	otal distortion + noise, % (measured	over a bandwidth of 22.4 Hz to 22.4 ki
Measured	Uncertainty (k = 2)	Measured	Uncertainty (k = 2)	Measured	Uncertainty (k = 2)
251.171	0.12	0.337	0.12	0.875	0.14
No What was the orie	entation of the piston	phone during the	calibration? Was it ho	rizontal? Was it vertical with the cavi	ity up? Was it vertical with the cavity
No What was the oried down? Vertical with the or What was the met one? The microphone r	entation of the piston cavity up, at the top o thod used to measure nethod (insert voltag	phone during the of the pistonphone e the generated so we technique)	calibration? Was it ho e pund pressure level? [	rizontal? Was it vertical with the cavi	ity up? Was it vertical with the cavity (insert voltage technique) or another
No What was the orie down? Vertical with the of What was the met one? The microphone r What was the refe LS2aP	entation of the piston cavity up, at the top o chod used to measure nethod (insert voltag erence measurement	phone during the of the pistonphone e the generated so re technique) microphone's typ	e calibration? Was it he e bound pressure level? D be use? Did you used a	rizontal? Was it vertical with the cavi bid you use the microphone method ( LS2P or another one?	ity up? Was it vertical with the cavity (insert voltage technique) or another
No What was the orie down? Vertical with the or What was the mel one? The microphone r What was the refe LS2aP What was the valu	entation of the piston cavity up, at the top o thod used to measure nethod (insert voltag erence measurement ue of the correction a	phone during the of the pistonphone e the generated so (e technique) microphone's typ pplied to the mea	calibration? Was it ho e bound pressure level? D be use? Did you used a isured sound pressure	rizontal? Was it vertical with the cavi iid you use the microphone method ( LS2P or another one?	ity up? Was it vertical with the cavity (insert voltage technique) or another
No What was the orie down? Vertical with the or What was the mel one? The microphone r What was the refe LS2aP What was the valu a) for load volume	entation of the piston cavity up, at the top o thod used to measure nethod (insert voltag erence measurement ue of the correction a e corresponding to th	phone during the of the pistonphone e the generated so the characteristic microphone's typ pplied to the mea e used microphon	calibration? Was it ho e bound pressure level? D be use? Did you used a isured sound pressure te?	rizontal? Was it vertical with the cavi bid you use the microphone method ( LS2P or another one? level:	ity up? Was it vertical with the cavity (insert voltage technique) or another
No What was the orie down? Vertical with the or one? The microphone r What was the refe LS2aP What was the valu a) for load volume -0.080 dB b) for the referen	entation of the piston cavity up, at the top o thod used to measure nethod (insert voltag erence measurement ue of the correction a e corresponding to the	phone during the of the pistonphone e the generated so e technique) microphone's typ pplied to the mea e used microphon oditions?	e calibration? Was it ho e bound pressure level? D be use? Did you used a isured sound pressure te?	rizontal? Was it vertical with the cavi iid you use the microphone method ( LS2P or another one?	ity up? Was it vertical with the cavity (insert voltage technique) or another
No What was the orie down? Vertical with the orie one? The microphone r What was the refe LS2aP What was the valu a) for load volume -0.080 dB b) for the referen Total: 0.029 dB, Ar	entation of the piston cavity up, at the top o thod used to measure nethod (insert voltag erence measurement ue of the correction a corresponding to th ce environmental cor nbient Pressure: 0.03	phone during the of the pistonphone e the generated so re technique) microphone's typ pplied to the mea e used microphon nditions? 15 dB, Relative Hui	calibration? Was it ho pound pressure level? I be use? Did you used a isured sound pressure te? midity: -0.006 dB	rizontal? Was it vertical with the cavi bid you use the microphone method ( LS2P or another one?	ity up? Was it vertical with the cavity (insert voltage technique) or another
No What was the orie down? Vertical with the orie one? The microphone r What was the refe LS2aP What was the valu a) for load volume -0.080 dB b) for the referen Total: 0.029 dB, Ar What was the met A rejection filter or	entation of the piston cavity up, at the top o thod used to measure nethod (insert voltag erence measurement ge of the correction a e corresponding to the ce environmental cor nbient Pressure: 0.03 thod used to measure fevice	phone during the of the pistonphone e the generated so (e technique) microphone's typ pplied to the mea e used microphon nditions? IS dB, Relative Hur ed the total distor	e calibration? Was it ho e bound pressure level? D be use? Did you used a issured sound pressure he? midity: -0.006 dB tion + noise? Did you t	rizontal? Was it vertical with the cavi bid you use the microphone method ( LS2P or another one? level:	ity up? Was it vertical with the cavity (insert voltage technique) or another
No What was the orie down? Vertical with the orie one? The microphone r What was the refe LS2aP What was the valu a) for load volume -0.080 dB b) for the referen Total: 0.029 dB, Ar What was the mel A rejection filter of Please, do not for uncertainty meas	entation of the piston cavity up, at the top o thod used to measure nethod (insert voltag erence measurement ue of the correction a e corresponding to the ce environmental cor mbient Pressure: 0.03 thod used to measure levice get to submit your fir surement" shall be us	phone during the of the pistonphone e the generated so the technique) microphone's typ pplied to the mea e used microphon nditions? IS dB, Relative Hur ed the total distor	calibration? Was it ho pound pressure level? I be use? Did you used a sured sound pressure he? midity: -0.006 dB tion + noise? Did you u idget. The ISO docume ice document.	rizontal? Was it vertical with the cavi old you use the microphone method ( LS2P or another one? level: use a rejection filter device (distortio	ity up? Was it vertical with the cavity (insert voltage technique) or another (insert voltage technique) or
No What was the orie down? Vertical with the orie one? The microphone r What was the refe LS2aP What was the value a) for load volume -0.080 dB b) for the referen Total: 0.029 dB, Ar What was the met A rejection filter or Please, do not for uncertainty meas Do you have any a	entation of the piston cavity up, at the top o thod used to measure nethod (insert voltag erence measurement ue of the correction a e corresponding to th ce environmental cor mbient Pressure: 0.03 thod used to measure levice get to submit your fir surement" shall be us idditional information	phone during the of the pistonphone e the generated so re technique) microphone's typ pplied to the mea e used microphon nditions? IS dB, Relative Hur ed the total distor	calibration? Was it ho pound pressure level? I pe use? Did you used a usured sound pressure te? midity: -0.006 dB tion + noise? Did you to tidget. The ISO docume tice document.	rizontal? Was it vertical with the cavi bid you use the microphone method ( LS2P or another one? level: use a rejection filter device (distortio ent "Evaluation of measurement data	ity up? Was it vertical with the cavity (insert voltage technique) or another (insert voltage technique) or
No What was the orie down? Vertical with the orie one? The microphone r What was the refe LS2aP What was the value a) for load volume a) for load volume d) for the referen Total: 0.029 dB, Ar What was the mel A rejection filter or Please, do not for uncertainty meas Do you have any a No	entation of the piston cavity up, at the top o thod used to measure method (insert voltag erence measurement ue of the correction a e corresponding to th ce environmental cor mbient Pressure: 0.03 thod used to measure levice get to submit your fir surement" shall be us idditional information	phone during the of the pistonphone e the generated so re technique) microphone's typ pplied to the mea e used microphon nditions? IS dB, Relative Hur ed the total distor	calibration? Was it ho pound pressure level? I pe use? Did you used a usured sound pressure te? midity: -0.006 dB tion + noise? Did you to tion + noise? Did you to tidget. The ISO docume tice document.	rizontal? Was it vertical with the cavi bid you use the microphone method ( LS2P or another one? level: use a rejection filter device (distortio ent "Evaluation of measurement data	ity up? Was it vertical with the cavity (insert voltage technique) or another (insert voltage technique) or

	Artefa	ct: Pistonphone ma	inufactured by Brüe	l and Kjaer, type 4228, serial number 2؛	836183
		Results obtained	using an <mark>one-inch r</mark>	eference measurement microphone	
National Met	trology Institute	NIST	(US)	]	
Period of t 11/	he calibration 7/2018	Air tempe 23	rature (°C) 3.3	Static pressure (kPa) 100.23	Relative humidity (%) 35
Sound pressure	evel dBre 20 uBa (c	orrected for load y	olume correspondi	ng to the microphone used and for the	reference environmental condition
Journa pressure i	Detern	nined	orume correspondi	Uncertai	nty ( $k = 2$ )
	123.	950		0.0	9 dB
P.S.: The determi	ned SPL should be rep	ported with three d	ecimals. The pilot I	aboratory will round it for two decimal	s.
Frequ	ency, Hz	Total harmoni	c distortion, %	Total distortion + noise, % (measured	over a bandwidth of 22.4 Hz to 22.4 kl
Measured	Uncertainty (k = 2)	Measured	Uncertainty (k = 2)	Measured	Uncertainty $(k = 2)$
251.172	0.12	0.342	0.14	0.818	0.21
down? Vertical with the What was the me one?	cavity up, at the top o thod used to measure	f the pistonphone e the generated sou	und pressure level?	Did you use the microphone method (	insert voltage technique) or another
	method (insert voltag	e technique)			
The microphone r		microphone's type	used? Did you use	a LS1P or another one?	
The microphone r What was the refo LS1P	erence measurement				
The microphone i What was the refe LS1P What was the value	erence measurement	pplied to the meas	ured sound pressur	e level:	
The microphone i What was the refu LS1P What was the value a) for load volume 0.280 dp	erence measurement ue of the correction a e corresponding to the	pplied to the meas e used microphone	ured sound pressur ?	e level:	
The microphone r What was the refe LS1P What was the vali a) for load volumi -0.280 dB b) for the referen	erence measurement ue of the correction a e corresponding to the ce environmental cor	pplied to the meas e used microphone nditions?	ured sound pressur ?	e level:	
The microphone i What was the refe LS1P What was the vali a) for load volumi -0.280 dB b) for the referen Total: 0.088 dB, An	erence measurement ue of the correction a e corresponding to the ce environmental cor mbient Pressure: 0.09	pplied to the meas e used microphone nditions? 4 dB, Relative Hum	ured sound pressur ? idity: -0.006 dB	e level:	
The microphone r What was the refe LS1P What was the valid a) for load volume -0.280 dB b) for the referen Total: 0.088 dB, Ai What was the me A rejection filter of	erence measurement ue of the correction aj e corresponding to th ce environmental cor mbient Pressure: 0.09 thod used to measure device	pplied to the meas e used microphone nditions? 4 dB, Relative Hum ed the total distorti	ured sound pressur ?? idity: -0.006 dB on + noise? Did you	e level:	n factor meter) or a FFT analyzer?
The microphone r What was the refe LS1P What was the vale a) for load volum -0.280 dB b) for the referen Total: 0.088 dB, Ai What was the me A rejection filter of Please, do not for uncertainty mea	erence measurement ue of the correction a e corresponding to th ce environmental cor mbient Pressure: 0.09 thod used to measure device get to submit your fir surement" shall be us	pplied to the meas e used microphone nditions? 4 dB, Relative Hum ed the total distorti nal uncertainty bud sed as the reference	ured sound pressur ?? idity: -0.006 dB on + noise? Did you get. The ISO docun e document.	e level: use a rejection filter device (distortio nent "Evaluation of measurement data	n factor meter) or a FFT analyzer? - Guide to the expression of
The microphone in What was the refe LS1P What was the valid a) for load voluming -0.280 dB b) for the referent Total: 0.088 dB, Ai What was the me A rejection filter of Please, do not for uncertainty mea Do you have any abuse	erence measurement ue of the correction aj e corresponding to the ce environmental cor mbient Pressure: 0.09 thod used to measure device get to submit your fir surement" shall be us additional information	pplied to the meas e used microphone nditions? 4 dB, Relative Hum ed the total distorti hal uncertainty bud sed as the reference n that you would li	ured sound pressur ? idity: -0.006 dB on + noise? Did you get. The ISO docum e document. ke to share to the pi	e level: use a rejection filter device (distortio ent "Evaluation of measurement data	n factor meter) or a FFT analyzer? - Guide to the expression of

# **B.4 CENAM**

Artefact: Pistonphone manufactured by Briel and Kjøer, type 4229, serial number 2836183, with its one-inch to half-inch adaptor type DP 0776 Results obtained with the one-inch to half-inch adaptor type DP 0776, i.e. using a half-inch reference measurement microphone National Metrology Institute CENAM Period of the calibration Air temperature (*C) Static pressure (kPa) Relative humidity (%) December 17,2018 to january 11,2019 23.2 101.31 S3.6 Sound pressure level, d8 re. 20,µPa (corrected for load volume corresponding to the microphone used and for the reference environmental conditio Determined Uncertainty (k = 2) 123.964 Corrected for load volume corresponding to the microphone used and for the reference environmental conditio Netermined Concertainty (k = 2) 123.964 Corrected for load volume corresponding to the microphone used and for the reference environmental conditio Netermined Concertainty (k = 2) 123.964 Corrected for load volume corresponding to the microphone used and for the reference environmental conditio Netermined Concertainty (k = 2) Measured Uncertainty (k								
Results obtained with the one-inch to half-inch adaptor type DP 0776, i.e. using a half-inch reference measurement microphone           National Metrology Institute         CENAM           Period of the calibration         Air temperature (*C)         Static pressure (kPa)         Relative humidity (%)           December 17,2018 to January 11,2019         23.2         101.31         SS.6           Sound pressure level, d8 re. 20 µPa (corrected for load volume corresponding to the microphone used and for the reference environmental condition         Determined         Uncertainty (k = 2)           9.5. The determined SPL should be reported with three decimals. The pilot laboratory will round it for two decimals.         Resured         Uncertainty (k = 2)           9.5. The determined SPL should be reported with three decimals. The pilot laboratory will round it for two decimals.         Neasured         Uncertainty (k = 2)           9.5. The measure frequency. THD and TON should be reported with one decimal exit than their respective uncertainty. The pilot laboratory will ro them for the same decimals number of the uncertainty.         Austional presentations of the uncertainty (k = 2)           9.5. The measurements are performed using an automated system which sequencially measures SPL (requency and 07. Overall time to determines the three parameters is 80 seconds. Specified measurement period in Clauses A.5.5.1, A.5.7.1 and A.5.8.1 is shorter than the actual time used in measurements reported in here.           What was the orientation of the pistonphone during the calibration? Was it horizontal? Was it vertical with the	Artefact: Pis	tonphone manufact	tured by Brüel and H	Kjaer, type 4228, se	rial number 2836183, with its	one-inch to h	alf-inch adaptor type I	DP 0776
National Metrology institute         CENAM           Period of the calibration         Air temperature (°C)         Static pressure (kPa)         Relative humidity (%)           December 17,2018 to January 11,2039         23.2         101.31         53.6           Sound pressure level, dB re. 20 µPa (corrected for load volume corresponding to the microphone used and for the reference environmental condition         0.00           P.5. The determined SPL should be reported with three decimals. The pilot laboratory will round it for two decimals.         0.00           P.5. The determined SPL should be reported with three decimals. The pilot laboratory will round it for two decimals.         0.00           P.5. The determined SPL should be reported with one decimal extra than their respective uncertainty (k = 2)         0.00           P.5. The measured frequency, THD and TO+N should be reported with one decimal extra than their respective uncertainty. The pilot laboratory will round then same decimals number of the uncertainty.         0.05           P.5. The measured frequency, THD and TO+N should be reported with one decimal actra than their respective uncertainty. The pilot laboratory will round the same decimals number of the uncertainty.         Nepulations from IEC 60942:2017 (Periodic tests) in the technical procedure use?           Are there any deviations from IEC 60942:2017 (Periodic tests) in the technical procedure use?         Network the actual time used in measurements reported in here.           What was the orientation of the pistonphone during the calibration? Was it horizontal? Was it vertical	Resu	ts obtained with the	e one-inch to half-ir	nch adaptor type DI	0776, i.e. using a half-inch re	eference mea	surement microphon	e
Period of the calibration         Air temperature (*C)         Static pressure (kPa)         Relative humidity (%)           December 17,2018 to January 11,2019         23.2         101.31         53.6           Sound pressure level, dB re. 20 µPa (corrected for load volume corresponding to the microphone used and for the reference environmental condition         0.06           P.5. The determined SPL should be reported with three decimals.         0.08         0.08           P.5. The determined SPL should be reported with three decimals.         Frequency, Hz         Total harmonic distortion, %         Total distortion + noise, % (measured over a bandwidth of 22.4 Hz to 22.4 Hz	National Met	rology Institute	CEN	MAM	]			
Period of the calibration         Air temperature (°C)         Static pressure (PAB)         Relative humidity (%)           December 17,2018 to January 11,2019         23.2         101.31         53.6           Sound pressure level, dB re. 20 µPa (corrected for load volume corresponding to the microphone used and for the reference environmental condition         53.6           Post: The determined 5PL should be reported with three decimals. The pilot laboratory will round it for two decimals.         0.08           P.S. The determined for uncertainty (k = 2)         Measured         Uncertainty (k = 2)           Measured         Uncertainty (k = 2)         Measured         Uncertainty (k = 2)           P.S. The measure frequency. The and ToN+ should be reported with one decimal extra than their respective uncertainty. The pilot laboratory will ro         1147         0.05           P.S. The measure frequency. The and TON+ should be reported with one decimal procedure used?         1147         0.05           Are there any deviations from IEC 60942:2017 (Periodic tests) in the technical procedure used?         1147         0.05           Measurements is 90 seconds. Specified measurement period in Clauses A.S.S.1, A.S.7.1 and A.S.8.1 is shorter than the actual time used in measurements reported in here.         1147         0.05           What was the orientation of the pistonphone during the calibration? Was it horizontal? Was it vertical with the cavity up? Was it vertical with the cavit down?         1147         1147								
Sound pressure level, dB re. 20 µPa (corrected for load volume corresponding to the microphone used and for the reference environmental condition           Determined         Uncertainty (k = 2)           123.904         0.08           P.S. The determined SPL should be reported with three decimals.         Total harmonic distortion, %         Total distortion + noise, % (measured over a bandwidth of 22.4 Hz to 22.4           Measured         [Incertainty (k = 2]]         Measured         Uncertainty (k = 2)           251.172         0.01         0.412         0.06         1.147         0.05           P.S. The measured frequency, Hz         Total harmonic distortion, %         Total distortion + noise, % (measured over a bandwidth of 22.4 Hz to 22.4           P.S. The measured frequency, Hz         0.0412         0.06         1.147         0.05           P.S. The measured frequency, Hz and TD-N should be reported with one decimal extra than their respective uncertainty, The pilot laboratory will ro them for the same decimals number of the uncertainty.         Measurements are performed using an automated system which sequencially measures SPL, frequency and DT. Overall time to determine the three reported in here.           What was the orientation of the pistonphone during the calibration? Was it horizontal? Was it vertical with the cavity up? Was it vertical with the cavit own?         Measurement with 3 microphones LS2P.           What was the reference measurement microphone?         Distonphone method (unser toltage technique) or anothe one? <td>Period of th</td> <td>e calibration</td> <td>Air tempe</td> <td>erature (°C)</td> <td>Static pressure (kPa</td> <td>a)</td> <td>Relative humidi</td> <td>ity (%)</td>	Period of th	e calibration	Air tempe	erature (°C)	Static pressure (kPa	a)	Relative humidi	ity (%)
Sound pressure level, dB re. 20 µPa (corrected for load volume corresponding to the microphone used and for the reference environmental condition           Determined         Uncertainty (k = 2)           123:994         0.08           P.5: The determined SPL should be reported with three decimals. The pilot laboratory will round it for two decimals.         Prequency, Hz           Frequency, Hz         Total harmonic distortion, %         Total distortion + noise, % (measured over a bandwidth of 22.4 Hz to 22.4 Hz to 22.4 Mz sourced           Measured         Uncertainty (k = 2)         Measured         Uncertainty (k = 2)           251.172         0.01         0.412         0.06         1.147         0.05           P.5: The measured frequency, TH2 and TD-N should be reported with one decimal extra than their respective uncertainty. The pilot laboratory will ro them for the same decimals number of the uncertainty.         Measurements are performed using an automated system which sequencially measures SPL, frequency and DT. Overall time to determine the three parameters is 30 seconds. Specified measurement period in Clauses A.5.5.1. A.5.7.1 and A.5.8.1 is shorter than the actual time used in measurements reported in here.           What was the orientation of the pistonphone during the calibration? Was it horizontal? Was it vertical with the cavity up? Was it vertical with the cavity up onting upwards.           What was the method used to measure the generated sound pressure level? Did you use the microphone method (insert volt	December 17,201	s to sandary 11,2019	2.	5.2	101.51		55.0	
Determined         Uncertainty (k = 2)           123.904         0.08           P.S.: The determined SPL should be reported with three decimals. The pilot laboratory will round it for two decimals.           Frequency, Hz         Total harmonic distortion, %         Total distortion + noise, % (measured uncertainty (k = 2)           251.17         0.01         0.412         0.06         1.147         0.05           P.S.: The measured frequency, HD and TD+N should be reported with one decimal extra than their respective uncertainty. The pilot laboratory will rot them for the same decimals number of the uncertainty.         0.06         1.147         0.05           P.S.: The measured frequency, HD and TD+N should be reported with one decimal extra than their respective uncertainty. The pilot laboratory will rot them for the same decimals number of the uncertainty.         0.68         1.147         0.05           Are there any deviations from IEC 60942:2017 (Periodic tests) in the technical procedure used?         Measurements are performed using an automated system which sequencially measures SPL, frequency and DT. Overall time to determine the three parameters is 90 seconds. Specified measurement period in Clauses A.5.3.1, A.5.7.1 and A.5.8.1 is shorter than the actual time used in measurements reported in here.           What was the orientation of the pistonphone during the calibration? Was it horizontal? Was it vertical with the cavity up? Was it vertical with the cavit down?         The pistonphone measure the generated sound pressure level? Did you use the microphone method (insert voltage technique) or anothr one?	Sound pressure le	evel, dB re. 20 µPa (	corrected for load v	olume correspondi	ng to the microphone used a	nd for the ret	ference environmenta	al condition
123.904     0.08       P.S.: The determined SPL should be reported with three decimals. The pilot laboratory will round it for two decimals.       P.S.: The determined SPL should be reported with three decimals. The pilot laboratory will round it for two decimals.       Measured     Uncertainty (k = 2)       P.S.: The decimal frequency. Hz     Total harmonic distortion, %     Total distortion + noise, % (measured     Uncertainty (k = 2)       P.S.: The measured frequency. Thou And TD4 should be reported with one decimal extra than their respective uncertainty. The pilot laboratory will ro them for the same decimals number of the uncertainty.     0.06       P.S.: The measure frequency. Thou And TD4 should be reported with one decimal extra than their respective uncertainty. The pilot laboratory will ro them for the same decimals number of the uncertainty.     0.05       P.S.: The measure frequency and DT. Overall time to determine the three parameters is 90 seconds. Specified measurement period in Clauses A.5.5.1, A.5.7.1 and A.5.8.1 is shorter than the actual time used in measurements reported in here.       What was the orientation of the pistonphone during the calibration? Was it horizontal? Was it vertical with the cavit down?       What was the reference measurement microphone's type use? Did you used a LS2P or another one?       What was the reference measurement microphone's type use? Did you used a LS2P or another one?       What was the reference measurement microphone's type use? Did you used a LS2P or another one?       Briel & K kjar's LS2P, type 4180.       What was the reference measurement microphone's type use? Did you used a LS2P or ano	•	Deter	mined			Uncertainty	(k = 2)	
P.S.: The determined SPL should be reported with three decimals. The pilot laboratory will round it for two decimals.         Frequency, Hz       Total harmonic distortion, %         Measured       Uncertainty (k = 2)         Measured       Uncertainty (k = 2)         25.1.12       0.01       0.412       0.064         P.S.: The measured frequency, ThD and TD-Ms should be reported with one decimal extra than their respective uncertainty. The pilot laboratory will ro them for the same decimals number of the uncertainty.         Are there any deviations from IEC 60942:2017 (Periodic tests) in the technical procedure used?         Measurements are performed using an automated system which sequencially measures SPL, frequency and DT. Overall time to determine the three aprameters is 90 seconds. Specified measurement period in Clauses A.5.5.1, A.5.7.1 and A.5.8.1 is shorter than the eavily up? Was it vertical with the cavit down?         The pistonphone was in vertical position with the cavity pointing upwards.         What was the orientation of the pistonphone during the calibration? Was it horizontal? Was it vertical with the cavity up? Was it vertical with the cavit down?         Direct measurement with 3 microphones IS2P.         What was the reference measurement period of the measured sound pressure level? Did you use the microphone method (insert voltage technique) or anothrone?         Briel & Kjør's IS2P, type 4180.         What was the value of the correction applied to the measured sound pressure level:         1 for lad volume correction.		123	.904			0.08		
Frequency, Hz         Total harmonic distortion, %         Total distortion + noise, % (measured over a bandwidth of 22.4 Hz to 22.4           Measured         Uncertainty (k = 2)         Measured         Uncertainty (k = 2)           251.17         0.01         0.42         0.06         1.147         0.05           P.5: The measured frequency, THD and TD+N should be reported with one decimal extra than their respective uncertainty. The pilot laboratory will ro         them for the same decimals number of the uncertainty.           Are there any deviations from IEC 60942:2017 (Periodic tests) in the technical procedure used?         Measurements are performed using an automated system which sequencially measures SPL, frequency and DT. Overall time to determine the three parameters is 90 seconds. Specified measurement period in Clauses A.5.5.1, A.5.7.1 and A.5.8.1 is shorter than the actual time used in measurements reported in here.           What was the orientation of the pistonphone during the calibration? Was it horizontal? Was it vertical with the cavity up? Was it vertical with the cavit own?           The pistonphone was in vertical position with the cavity pointing upwards.           What was the reference measurement microphone's type use? Did you use the microphone method (insert voltage technique) or another one?           Brüel & Kjær's LS2P, type 4180.           What was the reference measurement microphone's type use? Did you used a LS2P or another one?           Brüel & Kjær's LS2P, type 4180.           What was the value of the correction applied to the measured sound pressure level: <td>P.S.: The determin</td> <td>ed SPL should be re</td> <td>ported with three o</td> <td>lecimals. The pilot</td> <td>laboratory will round it for tw</td> <td>o decimals.</td> <td></td> <td></td>	P.S.: The determin	ed SPL should be re	ported with three o	lecimals. The pilot	laboratory will round it for tw	o decimals.		
Measured         Uncertainty (k = 2)           25.172         0.01         0.412         0.66         1.147         0.05           P5.3: The measured frequency, TMB and TN+N should be reported with one decimal extra than their respective uncertainty. The pilot laboratory will ro them for the same decimals number of the uncertainty.         0.65           Are there any deviations from IEC 60942:2017 (Periodic tests) in the technical procedure used?	Frequ	ency, Hz	Total harmon	ic distortion. %	Total distortion + noise. % (n	neasured ove	r a bandwidth of 22.4	Hz to 22.4 k
251.172       0.01       0.412       0.05       1.147       0.05         P.S. The measured frequency, THD and TD+N should be reported with one decimal extra than their respective uncertainty. The pilot laboratory will ro them for the same decimals number of the uncertainty.       P.S. The measured frequency, THD and TD+N should be reported with one decimal extra than their respective uncertainty. The pilot laboratory will ro them for the same decimals number of the uncertainty.         Are there any deviations from IEC 60942:2017 (Periodic tests) in the technical procedure used?       Measurements are performed using an automated system which sequencially measures SPL, frequency and DT. Overall time to determine the three parameters is 90 seconds. Specified measurement period in Clauses A.S.S.1, A.S.7.1 and A.S.8.1 is shorter than the actual time used in measurements reported in here.         What was the orientation of the pistonphone during the calibration? Was it horizontal? Was it vertical with the cavity up? Was it vertical with the cavity down?         The pistonphone was in vertical position with the cavity pointing upwards.         What was the method used to measure the generated sound pressure level? Did you used a LS2P or another one?         Briel & Kjær's LS2P, type 4180.         What was the reference measurement microphone? Stype use? Did you used a LS2P or another one?         Briel Number       2208276       Load Volume Corr. 0.112404       dB	Measured	Uncertainty (k = 2)	Measured	Uncertainty (k = 2)	Measured		Uncertainty (k	= 2)
P.S.: The measured frequency, THD and TD-N should be reported with one decimal extra than their respective uncertainty. The pilot laboratory will ro them for the same decimals number of the uncertainty. Are there any deviations from IEC 60942:2017 (Periodic tests) in the technical procedure used? Measurements are performed using an automated system which sequencially measures SPL, frequency and DT. Overall time to determine the three parameters is 90 seconds. Specified measurement period in Clauses A.S.5.1, A.S.7.1 and A.S.8.1 is shorter than the actual time used in measurements reported in here. What was the orientation of the pistonphone during the calibration? Was it horizontal? Was it vertical with the cavity up? Was it vertical with the cavit down? The pistonphone was in vertical position with the cavity pointing upwards. What was the method used to measure the generated sound pressure level? Did you use the microphone method (insert voltage technique) or anothone? Direct measurement with 3 microphones LS2P. What was the reference measurement microphone's type use? Did you used a LS2P or another one? Bruel & Kjær's LS2P, type 4180. What was the veference measurement microphone? Serial Number 2208276 Load Volume Corr. 0.112404 dB Serial Number 199197 Load Volume Corr. 0.112404 dB Serial Number 1208286 Load Volume Corr. 0.112404 dB Serial Number 2208276 Load Volume Corr. 0.112404 dB Serial Number 1208286 Load Volume Corr. 0.112404 dB Serial Number 1208286 Load Volume Corr. 0.112404 dB Serial Number 1208276 Load Volume Corr. 0.10240 dB Serial Number 1208276 Load Volume Corr. 0.112404 dB Serial Number 1208276 Load Volume Corr. 0.112404 dB Serial Number 1208276 Load Volume Corr. 0.112404 dB Serial Number 1208276 Load Volume Corr. 0.10240 dB Serial Number 1208276 Load Volume Corr. 0.1005 dB Serial Number 1698197 Load Volume Corr. 0.0003 dB Serial Number 1698197 Load Volume Corr. 0.0004 dB Serial Number 1698197 Load Volume Corr. 0.0005 dB Serial Number 1698197 Load Volume Corr. 0.0005	251.172	0.01	0.412	0.06	1.147		0.05	
Are there any deviations from IEC 60942:2017 (Periodic tests) in the technical procedure used? Measurements are performed using an automated system which sequencially measures SPL, frequency and DT. Overall time to determine the three parameters is 50 seconds. Specified measurement period in Clauses A.5.5.1, A.5.7.1 and A.5.8.1 is shorter than the actual time used in measurements reported in here. What was the orientation of the pistonphone during the calibration? Was it horizontal? Was it vertical with the cavity up? Was it vertical with the cavit down? The pistonphone was in vertical position with the cavity pointing upwards. What was the method used to measure the generated sound pressure level? Did you use the microphone method (insert voltage technique) or another one? Direct measurement with 3 microphones LS2P. What was the reference measurement microphone's type use? Did you used a LS2P or another one? Briel & Kjær's LS2P, type 4180. What was the value of the correction applied to the measured sound pressure level: a) for load volume corresponding to the used microphone? Serial Number 208276 Load Volume Corr. [0.112404 dB b) for the reference environmental conditions? Microphone Pressure Correction: 0.0005 dB Microphone Pressure Correction: 0.0009 dB Pistonphone Pressure Correction: 0.0009 dB Pistonphone Tenser Correction: 0.0011 dB Microphone Pressure Correction: 0.0011 dB Pistonphone Pressure Correction: 0.0005 dB Pistonphone Pressure Correction: 0.0005 dB Pistonphone Pressure Correction: 0.0011 dB Pistonphone Pressure Correction: 0.0005 dB Pistonphone Pressure Correction	them for the same	e decimals number of	of the uncertainty.		contar exact than then respe	curve unicertu	inty. The phot haborat	ory whited
Are there any deviations from IEC 60942:2017 (Periodic tests) in the technical procedure used?  Measurements are performed using an automated system which sequencially measures SPL, frequency and DT. Overall time to determine the three parameters is 90 seconds. Specified measurement period in Clauses A.5.5.1, A.5.7.1 and A.5.8.1 is shorter than the actual time used in measurements reported in here.  What was the orientation of the pistonphone during the calibration? Was it horizontal? Was it vertical with the cavity up? Was it vertical with the cavit down?  The pistonphone was in vertical position with the cavity pointing upwards.  What was the method used to measure the generated sound pressure level? Did you use the microphone method (insert voltage technique) or another one?  Direct measurement with 3 microphones LS2P.  What was the reference measurement microphone's type use? Did you used a LS2P or another one? Brüel & Kjær's LS2P, type 4180.  What was the value of the correction applied to the measured sound pressure level: a) for load volume corre. [0.112404] Breial Number 2008276 Load Volume Corr. [0.112404] Breial Number 2008276 Load Volume Corr. [0.112404] Breial Number 2008286 Load Volume Corr. [0.112404] Breial Number 2008276 Load Volume Corr. [0.112			-					
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Pistophone Pressure Correction: 0.0000 dB Pistophone Amount of the Amoun	reported in here. What was the orie down? The pistonphone v What was the met one? Direct measureme What was the refe Brüel & Kjær's LS2 What was the valu a) for load volume Serial Number Serial Number Serial Number Serial Number Serial Number Serial Number Pistonphone Pressur Microphone Pressur Pistonphone Temper	antation of the pistor was in vertical positi hod used to measur ent with 3 microphor rence measuremen p, type 4180. e of the correction a corresponding to th 2208276 1698197 1208286 e environmental co r e correction: ature + Humidity Correction ature + Humidity Correction c correction:	easurement period on with the cavity p e the generated so nes LS2P. t microphone's type t microphone's type eused microphone Load Volume Corr. Load Volume Corr. Load Volume Corr. Load Volume Corr. cad Volume Corr. load Volume Corr.	In Clauses A.5.5.1, calibration? Was it i pointing upwards. und pressure level? e use? Did you used e use? Did you used curred sound pressu ?? 0.112404 0.112404 0.112404 0.112404 0.112404 0.0005 -0.0004 0.0009 -0.0063	A.S.7.1 and A.S.8.1 is shorter horizontal? Was it vertical wit Did you use the microphone la LS2P or another one? la LS2P or a	than the actu	al time used in measu ip? Was it vertical with ert voltage technique)	) or anothe
Distonching Temperature 4 Humidity Correction Correction: 00000 dB	reported in here. What was the orie down? The pistonphone of What was the met one? Direct measureme What was the refe Brüel & Kjær's LS2 What was the valu a) for load volume Serial Number Serial Number Serial Number Serial Number b) for the reference Mic. Serial Number Microphone Temper Pistonphone Temper Pistonphone Temper Mic. Serial Number	aconds. Specified m ntation of the pistor vas in vertical positi hod used to measur int with 3 microphor rence measuremen p, type 4180. e of the correction a corresponding to th 2208276 1698197 1208276 1698197 1208276 1698197 1208286 e correction: ature + Humidity Correction ature + Humidity Correction: ature + Humi	easurement period on with the cavity p e the generated so hes LS2P. t microphone's type applied to the meas re used microphone Load Volume Corr. Load Volume Corr.	In Clauses A.5.5.1, calibration? Was it i pointing upwards. und pressure level? e use? Did you used sured sound pressu ? 0.112404 0.112404 0.112404 0.112404 0.112404 0.0005 -0.0004 0.0009 -0.0063	A.S.7.1 and A.S.8.1 is shorter orizontal? Was it vertical wit Did you use the microphone I a LS2P or another one? I a LS2	than the actu	al time used in measu ip? Was it vertical with ert voltage technique)	) or anothe
	reported in here. What was the orie down? The pistonphone of What was the met one? Direct measureme What was the refe Brüel & Kjær's LS2 What was the valu a) for load volume Serial Number Serial Number Serial Number Serial Number b) for the referent Mic. Serial Number Microphone Pressur Microphone Temper Mic. Serial Number Microphone Temper	aconds. Specified m ntation of the pistor vas in vertical positi hod used to measur int with 3 microphor rence measuremen P, type 4180. e of the correction is corresponding to th 208276 1698197 2208276 1698197 2208286 is environmental correction: ature + Humidity Correction: ature + Humidity Correction: ature + Humidity Correction: e correction: ature + Humidity Correction: e correction: ature + Humidity Correction: e correction: e correction: ature + Humidity Correction: e correction:	easurement period on with the cavity p e the generated soo hes LS2P. t microphone's type sepplied to the meas he used microphone Load Volume Corr. Load Volume Corr. Load Volume Corr. ditions? 2208276 ction: tetion Correction: 1698197 ction:	In Clauses A.5.5.1, calibration? Was it i pointing upwards. und pressure level? und pressure level? e use? Did you used sured sound pressu ? 0.112404 0.112404 0.112404 0.112404 0.112404 0.0005 -0.0004 0.0009 -0.0063 0.0011 -0.0005	A.S.7.1 and A.S.8.1 is shorter horizontal? Was it vertical wit borizontal? Was it vertical wit	than the actu	al time used in measu ip? Was it vertical with ert voltage technique)	) or anothe
	reported in here. What was the orie down? The pistonphone v What was the met one? Direct measureme What was the refe Brüel & Kjær's LS2 What was the valu a) for load volume Serial Number Serial Number Serial Number b) for the referent Mic. Serial Number Mic. Serial Number Pistonphone Temper Pistonphone Temper Microphone Temper Pistonphone Temper Pistonphone Temper Pistonphone Temper	econds. Specified m ntation of the pistor vas in vertical positi hod used to measur nt with 3 microphor rence measuremen P, type 4180. e of the correction : corresponding to th 2208276 1698197 1208286 re environmental co r e Correction: ature + Humidity Correct	easurement period nphone during the o on with the cavity p e the generated so nes LS2P. t microphone's type t microphone's type t microphone's type t microphone's type construction Load Volume Corr. Load Volume Corr. 1698197 ction: ction:	In Clauses A.5.5.1, calibration? Was it i pointing upwards. und pressure level? e use? Did you used e use? Did you used 0.112404 0.112404 0.112404 0.112404 0.112404 0.112404 0.0005 -0.0004 0.0009 -0.0063 -0.0005 0.0001 -0.0005 0.0005 -0.0006	A.S.7.1 and A.S.8.1 is shorter horizontal? Was it vertical wit 2 Did you use the microphone i a LS2P or another one? The level: dB dB dB dB dB dB dB dB dB dB	than the acture that the cavity of method (ins method (ins) method (i	al time used in measu ip? Was it vertical with ert voltage technique)	) or anothe

Microphone Pressur	e Correction:		0.0009	dB					
Microphone Tempera	ature + Humidity Correct	ion:	-0.0002	dB					
Pistonphone Pressur	e Correction:		0.0018	dB					
Pistonphone Temper	ature + Humidity Correc	tion Correction:	-0.0060	dB					
What was the met	hod used to measure	d the total disto	rtion + noise? D	id you use a rejecti	on filter devic	e (distorti	on factor m	eter) or	a FFT analyzer?
Hewlett Packard D	istortion Analyser, m	odel 8903E. al uncertainty bu	udget. The ISO (	document "Evaluati	ion of measur	ement dat	a - Guide to	the exp	ression of
Hewlett Packard D	istortion Analyser, m get to submit your fin- urement" shall be use	odel 8903E. al uncertainty bu	udget. The ISO o	document "Evaluat	ion of measur	ement dat	a - Guide to	the exp	ression of
Hewlett Packard D Please, do not forg uncertainty meas	istortion Analyser, m get to submit your fin urement" shall be use	odel 8903E. al uncertainty bu ed as the referen	udget. The ISO once document.	document "Evaluat	ion of measur	ement dat	a - Guide to	the exp	ression of
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Hewlett Packard D Please, do not forg uncertainty meas Do you have any a	istortion Analyser, m tet to submit your fin urement" shall be uso dditional information	odel 8903E. al uncertainty bu ed as the referen that you would	udget. The ISO of the	document "Evaluat	ion of measur y?	ement dat	a - Guide to	o the exp	ression of

Artefact: Pistophone manufactured by Brüel and Kjær, type 4228, serial number 2836183         Results obtained using an one-inch reference measurement microphone         National Metrology Institute       CENAM         Period of the calibration       Air temperature (°C)       Static pressure (kPa)       Relative humidity (12019-01-10)         Sound pressure level, dB re. 20 µPa (corrected for load volume corresponding to the microphone used and for the reference environmental or uncertainty (k = 2)       0.66         P.S.: The determined SPL should be reported with three decimals. The pilot laboratory will round it for two decimals.       0.66         P.S.: The measured frequency, HZ       Total harmonic distortion, %       Total distortion + noise, % (measured over a bandwidth of 22.4 HZ / Measured         Measured Increasing V(k = 2)       Measured       Uncertainty (k = 2)       Measured         Measured frequency, HZ       Total harmonic distortion, %       Total distortion + noise, % (measured over a bandwidth of 22.4 HZ / Measured         Measurements are performed using an automated system which sequencial measures SPL, frequency and DT. Overall time to determine the trainmentes is observed.       0.62         P.S.: The measured requency, THD and TD-N should be reported with one decimal extra than their respective uncertainty. The pilot laboratory them for the same decimals number of the uncertainty.         Are there any deviations from IEC 60942:2017 (Periodic tests) in the technical procedure used? <t< th=""><th>Artefact: Pistonphone manufactured by Bruel and Kjaer, type 4228, serial number 2836183         INetrology Institute       CENAM         Interology Institute       CENAM         I of the calibration       Air temperature (°C)       Static pressure (kPa)       Relative humidity (%)         2019 01:10       23.2       101.3       45.1         arra level, dB re. 20 µPa (corrected for load volume corresponding to the microphone used and for the reference environmental conditio       Uncertainty (k = 2)         123.917       0.06       0.06         requency, Hz       Total harmonic distortion, %       Total distortion + noise, % (measured over a bandwidth of 22.4 Hz to 22.4 Hz t</th><th></th><th></th><th></th><th></th><th></th><th></th></t<>	Artefact: Pistonphone manufactured by Bruel and Kjaer, type 4228, serial number 2836183         INetrology Institute       CENAM         Interology Institute       CENAM         I of the calibration       Air temperature (°C)       Static pressure (kPa)       Relative humidity (%)         2019 01:10       23.2       101.3       45.1         arra level, dB re. 20 µPa (corrected for load volume corresponding to the microphone used and for the reference environmental conditio       Uncertainty (k = 2)         123.917       0.06       0.06         requency, Hz       Total harmonic distortion, %       Total distortion + noise, % (measured over a bandwidth of 22.4 Hz to 22.4 Hz t						
Results obtained using an one-lick reference measurement microphone           National Metrology institute         CENAM           Period of the calibration         Air temperature ( <sup>1</sup> C)         Static pressure (kPa)         Relative humidity ( 2019-01-10         23.2         101.3         45.1           Sound pressure level, dB re. 20 µPa (corrected for load volume corresponding to the microphone used and for the reference environmental or Determined         Uncertainty (k = 2)         0.66           P.5: The determined SPL should be reported with three decimals. The pilot laboratory will round if for two decimals.         Frequency, Hz         Total harmonic distortion, %         Total distortion + noise, % (measured over a bandwidth of 22.4 Hz)           Measured         Uncertainty (k = 2)         Measured         Uncertainty (k = 2)         0.06           P.5: The determined SPL should be reported with three decimals are performed using an automated system which sequencially measures SPL, frequency and DT. Overall time to determine the P parameters is 90 seconds. Specified measurement period in Clauses A.5.5.1, A.5.7.1 and A.5.8.1 is shorter than the actual time used in measurer reported in here.           What was the orientation of the pistonphone during the calibration? Was it horizontal? Was it vertical with the cavity up? Was it vertical with the davity pointing upwards.           What was the reference measurement microphone's type used? Did you use the microphone method (insert voltage technique) or one?           Direct measurement with 3 microphones LS2P.           What was the	Results obtained using an one-inch reference measurement microphone         IMetrology Institute       CENAM         I of the calibration       Air temperature (°C)       Static pressure (kPa)       Relative humidity (%)         2019-01-10       23.2       101.3       45.1         urue level, dB re. 20 µPa (corrected for load volume corresponding to the microphone used and for the reference environmental condition       Uncertainty (k = 2)         213.917       0.06         emined SPL should be reported with three decimals. The pilot laboratory will round it for two decimals.         requency, Hz       Total harmonic distortion, %       Total distortion + noise, % (measured over a bandwidth of 22.4 Hz to 22.4         0       0.033       0.06       0.762       0.06         same decimals number of the uncertainty (k = 2)       0.06       0.722       0.06         same decimals number of the uncertainty.       The plot laboratory will romain function for 12.6 M22.2017 (Periodic tests) in the technical procedure used?       13 seconds. Specified measurement period in Clauses A.5.3.1.A.5.7.1 and A.5.8.1 is shorter than the actual time used in measurements are.         or orientation of the pistorphone during the calibration? Was it horizontal? Was it vertical with the cavity up? Was it vertical with the cavit pointing upwards.         reflection applied to the measured sound pressure level:         uncertainty of used volume Corr. [0.2556       d8       1		Artefa	ict: Pistonphone ma	anufactured by Brü	el and Kjaer, type 4228, serial numbe	r 2836183
National Metrology Institute         CENAM           Period of the calibration         Air temperature (°C)         Static pressure (kPa)         Relative humidity ( 2013-01-10         23.2         101.3         45.1           Sound pressure level, dB re. 20 µPa (corrected for load volume corresponding to the microphone used and for the reference environmental of Determined         Uncertainty (k = 2)         0.06           P.5: The determined SPL should be reported with three decimals. The pilot laboratory will round it for two decimals.         Foreuro, KE         0.06         0.762         0.06           P.5: The determined SPL should be reported with one decimals. The pilot laboratory will round it for two decimals.         0.06         0.762         0.06 <t< td=""><td>Metrology Institute       CENAM         i of the calibration       Air temperature (°C)       Static pressure (kPa)       Relative humidity (S)         2019-01-10       23.2       101.3       45.1         ure level, 86 re. 20 µPa (corrected for load volume corresponding to the microphone used and for the reference environmental condition       Determined       Uncertainty (k = 2)         123.917       0.06       0.06         minied SPL should be reported with three decimals. The pilot laboratory will round it for two decimals.       Fergueno, Hz       Total harmonic distortion, %       Total distortion + noise, % (measured over a bandwidth of 22.4 Hz to 22.4 distortion + noise, % (measured over a bandwidth of 22.4 Hz to 22.4 distortion + noise, % (measured over a bandwidth of 22.4 Hz to 22.4 distortion + noise, % (measured over a bandwidth of 22.4 Hz to 22.4 distortion + noise, % (measured over a bandwidth of 22.4 Hz to 22.4 distortion + noise, % (measured over a bandwidth of 22.4 Hz to 22.4 distortion + noise, % (measured over a bandwidth of 22.4 Hz to 22.4 distortion + noise, % (measured bardwidth of 22.4 Hz to 22.4 distortion + noise, % (measured bardwidth of 22.4 Hz to 22.4 distortion + noise, % (measured bardwidth of 22.4 Hz to 22.4 distortion + noise, % (measured forquency, HZ and ToN+ should be reported with one decimal extra than their respective uncertainty. The pilot laboratory will ro         deviations from IEC 60942:2017 (Periodic tests) in the technical procedure used?      </td><td></td><td></td><td>Results obtained</td><td>using an one-inch</td><td>reference measurement microphone</td><td>2</td></t<>	Metrology Institute       CENAM         i of the calibration       Air temperature (°C)       Static pressure (kPa)       Relative humidity (S)         2019-01-10       23.2       101.3       45.1         ure level, 86 re. 20 µPa (corrected for load volume corresponding to the microphone used and for the reference environmental condition       Determined       Uncertainty (k = 2)         123.917       0.06       0.06         minied SPL should be reported with three decimals. The pilot laboratory will round it for two decimals.       Fergueno, Hz       Total harmonic distortion, %       Total distortion + noise, % (measured over a bandwidth of 22.4 Hz to 22.4 distortion + noise, % (measured over a bandwidth of 22.4 Hz to 22.4 distortion + noise, % (measured over a bandwidth of 22.4 Hz to 22.4 distortion + noise, % (measured over a bandwidth of 22.4 Hz to 22.4 distortion + noise, % (measured over a bandwidth of 22.4 Hz to 22.4 distortion + noise, % (measured over a bandwidth of 22.4 Hz to 22.4 distortion + noise, % (measured over a bandwidth of 22.4 Hz to 22.4 distortion + noise, % (measured bardwidth of 22.4 Hz to 22.4 distortion + noise, % (measured bardwidth of 22.4 Hz to 22.4 distortion + noise, % (measured bardwidth of 22.4 Hz to 22.4 distortion + noise, % (measured forquency, HZ and ToN+ should be reported with one decimal extra than their respective uncertainty. The pilot laboratory will ro         deviations from IEC 60942:2017 (Periodic tests) in the technical procedure used?			Results obtained	using an one-inch	reference measurement microphone	2
Period of the calibration         Air temperature (*C)         Static pressure (kPa)         Relative humidity ( 2019-01-10           2019-01-10         23.2         101.3         45.1           Sound pressure level, dB re. 20 µPa (corrected for load volume corresponding to the microphone used and for the reference environmental co Determined         Uncertainty (k = 2)           123.917         0.06         0.06           P.S.: The determined SPL should be reported with three decimals. The pilot laboratory will round it for two decimals.         Terequency, Ht           Measured         Uncertainty (k = 2)         0.06           P.S.: The measured frequency, Ht         Total harmonic distortion, %         Total distortion + noise, % (measured over a bandwidth of 22.4 Hz in the for the same decimals number of the uncertainty (k = 2)           P.S.: The measured frequency, HL         Total harmonic distortion, %         Total distortion + noise, % (measured over a bandwidth of 22.4 Hz in them for the same decimals number of the uncertainty.           Weature frequency, HL         O.01         0.393         0.06         0.762         0.06           P.S.: The measured frequency, THD and TD+N should be reported with one decimal extra than their respective uncertainty. The pilot laboratory them for the same decimals number of the uncertainty.         The pilotonphone during the calibration? Was it horizontal?           Weat was the orientation of the pistonphone during the calibration? Was it horizontal?         Was it vertical with th	Intervence         Lether           1 of the calibration         Air temperature (°C)         Static pressure (kPa)         Relative humidity (%)           2019-01-10         23.2         101.3         45.1           uure level, d8 re. 20 µPa (corrected for load volume corresponding to the microphone used and for the reference environmental condition         0.6           Uncertainty (k = 2)         0.06         0.06           123.317         0.06         0.06           in Uncertainty (k = 2)         0.06         0.06           in Uncertainty (k = 2)         Measured         Uncertainty (k = 2)           0.01         0.333         0.06         0.762         0.06           is under of the uncertainty.         Total harmonic distrition, %         Fotal distortion + noise, % (measured or a bandwidth of 22.4 Hz to	National Mot	rolom/Institute	CEN		]	
Period of the calibration         Air temperature (*C)         Static pressure (kPa)         Relative humidity ( 2019-01-10           2019-01-10         23.2         101.3         45.1           Sound pressure level, dB re. 20 µPa (corrected for load volume corresponding to the microphone used and for the reference environmental or Determined         Uncertainty (k = 2)         0.06           P.S.: The determined SPL should be reported with three decimals. The pilot laboratory will round it for two decimals.         Incertainty (k = 2)         0.06           P.S.: The determined SPL should be reported with three decimals. The pilot laboratory will round it for two decimals.         Uncertainty (k = 2)         Measured         Uncertainty (k = 2)         0.06         0.752         0.06           P.S.: The measured frequency, TH2 and TD-N should be reported with one decimal extra than their respective uncertainty. The pilot laboratory them for the same decimals number of the uncertainty.         The pilot laboratory           Are there any deviations from IEC 60942:2017 (Periodic tests) in the technical procedure used?         Weasurements are performed using an automated system which sequencially measures SPL, frequency and DT. Overall time to determine the trapparters is 90 seconds. Specified measurement period in Clauses A.S.S.1, A.S.7.1 and A.S.8.1 is shorter than the actual time used in measurer reported in here.           WMat was the orientation of the pistonphone during the calibration? Was it horizontal? Was it vertical with the cavity up? Was it vertical with th down?         The pistonphone method useret technique) or one?	i of the callibration       Air temperature (°C)       Static pressure (kPa)       Relative humidity (%)         2019-01-10       23.2       101.3       45.1         2019-01-10       23.2       101.3       45.1         strue level, dB re. 20 µPa (corrected for load volume corresponding to the microphone used and for the reference environmental condition Determined       Uncertainty (k = 2)         123.917       0.06         emined SPL should be reported with three decimals. The pilot laboratory will round it for two decimals.       Incertainty (k = 2)         i 0.01       0.393       0.06       0.762       0.06         asured frequency. THD and TD+N should be reported with one decimal extra than their respective uncertainty (k = 2)       0.06       0.762       0.06         sare decimals number of the uncertainty.	ivational Met	lology institute		VHIVI	1	
2019-01-10       23.2       101.3       45.1         Sound pressure level, dB re. 20 µPa [corrected for load volume corresponding to the microphone used and for the reference environmental or Determined       Uncertainty (k = 2)         123.917       0.06         P.S.: The determined SPL should be reported with three decimals. The pilot laboratory will round it for two decimals.         Frequency, Hz       Total harmonic distortion, %       Total distortion + noise, % (measured over a bandwidth of 22.4 Hz)         Measured       Uncertainty (k = 2)       0.06       0.762       0.06         P.S.: The measured frequency, HB and TD+N should be reported with one decimal extra than their respective uncertainty. The pilot laboratory them for the same decimals number of the uncertainty.       0.06       0.762       0.06         P.S.: The measured frequency, HB and TD-N should be reported with one decimal extra than their respective uncertainty. The pilot laboratory them for the same decimals number of the uncertainty.       The pilot laboratory         Are there any deviations from IEC 60942:2017 (Periodic tests) in the technical procedure used?       Measurements is 90 seconds. Specified measurement period in Clauses A.5.5.1, A.5.7.1 and A.5.8.1 is shorter than the actual time used in measurer reported in here.         What was the orientation of the pistonphone during the calibration? Was it horizontal? Was it vertical with the cavity up? Was it vertical with the dowi?         The pistonphone was in vertical position with the cavity pointing upavards.         What	2019-01-10     23.2     101.3     45.1       urre level, dB re. 20 µPa (corrected for load volume corresponding to the microphone used and for the reference environmental condition Determined     Uncertainty (k = 2)       123.917     0.06       environd SP, should be reported with three decimals. The pitot laboratory will round it for two decimals.       requency, Hz     Total harmonic distortion, %       full uncertainty (k = 2)     Measured     Uncertainty (k = 2)       0.01     0.393     0.06     0.762     0.06       same decimals number of the uncertainty.     0.06     0.762     0.06       same decimals number of the uncertainty.     0.06     0.762     0.06       requestions from IEC 60942:2017 (Periodic tests) in the technical procedure used?     0.06     0.762       st are performed using an automated system which sequencially measures SPL, frequency and DT. Overall time to determine the three so so reintation of the pistonphone during the calibration? Was it horizontal? Was it vertical with the cavity up? Was it vertical with the cavit used in measurements erre.       a reference measure the generated sound pressure level? Did you use the microphone method (insert voltage technique) or another reference measurement microphone?       reference measu	Period of th	e calibration	Air tempe	rature (°C)	Static pressure (kPa)	Relative humidity (%)
Sound pressure level, dB re. 20 µPa (corrected for load volume corresponding to the microphone used and for the reference environmental or uncertainty (k = 2)           123.917         0.06           P.S.: The determined SPL should be reported with three decimals. The pilot laboratory will round it for two decimals.           Frequency, Hz           Total harmonic distortion, %           Total distortion, noise, % (measured over a bandwidth of 22.4 Hz)           Measured frequency, Hz           Total distortion, %           Total distortion, No           Total Ditota distortion, No	ure level, dB re. 20 µPa (corrected for load volume corresponding to the microphone used and for the reference environmental condition Determined Determined Uncertainty (k = 2) 123-917 0.06 remined SP, should be reported with three decimals. The pilot laboratory will round it for two decimals. requency, Hz Total harmonic distortion, % fotal distortion + noise, % (measured over a bandwidth of 22.4 Hz to 22.4 d Uncertainty (k = 2) Measured Uncertainty (k = 2) Measured Uncertainty (k = 2) 0.06 0.762 0.06 sured frequency, THD and TDH's hould be reported with one decimal extra than their respective uncertainty. The pilot laboratory will ro same decimals number of the uncertainty. d eviations from IEC 60942:2017 (Periodic tests) in the technical procedure used? ts are performed using an automated system which sequencially measures SPL, frequency and DT. Overall time to determine the three so reintation of the pistonphone during the calibration? Was it horizontal? Was it vertical with the cavity up? Was it vertical with the cavit one was in vertical position with the cavity pointing upwards. method used to measure the generated sound pressure level? Did you use the microphone method (insert voltage technique) or another rement with 3 microphones LS2P. reference measurement microphone? right be correction applied to the measured sound pressure level: Unume corresponding to the used microphone? right be correction. papelled to the measured sound pressure level: Unume corresponding to the used microphone? right 1234027 Load Volume Corr. 0.2356 dB remeter with a microphone (D.2356 dB right 1234027 Load Volume Corr. 0.2356 dB right 134027 Load Volume Corr. 0.2356 dB	2019	-01-10	23	3.2	101.3	45.1
Decision create and include real contrection mater volume corresponding to the interponder based and interpondere based and interponder based and interpondere based and interp	Use test part (bit fector for the volume corresponding to the minociphical cost and for the respected entrophilation of the sector of	Sound procesure la	avel dB re 20 uBe 4	corrected for load w	olume correspond	ng to the microphone used and fort	he reference environmental condition
123.917       0.06         P.S.: The determined SPL should be reported with three decimals. The pilot laboratory will round it for two decimals.         Frequency, Hz       Total harmonic distortion, %       Total distortion + noise, % (measured or a bandwidth of 22.4 Hz)         Measured       Uncertainty (k = 2)       Measured       Uncertainty (k = 2)       0.66       0.762       0.66         P.S.: The measured requency, THD and TD+N should be reported with one decimal extra than their respective uncertainty. The pilot laboratory them for the same decimals number of the uncertainty.       0.66       0.762       0.66         P.S.: The measured frequency, THD and TD+N should be reported with one decimal extra than their respective uncertainty. The pilot laboratory them for the same decimals number of the uncertainty.       0.66       0.762       0.66         Are there any deviations from IEC 60942:2017 (Periodic tests) in the technical procedure used?       Measurements are performed using an automated system which sequencially measures SPL, frequency and DT. Overall time to determine the t parameters is 90 seconds. Specified measurement period in Clauses A.5.5.1, A.5.7.1 and A.5.8.1 is shorter than the actual time used in measurer reported in here.         What was the orientation of the pistonphone during the calibration? Was it horizontal? Was it vertical with the cavity up? Was it vertical with th down?       The pistonphone was in vertical position with the cavity pointing upwards.         What was the method used to measure the generated sound pressure level? Did you use the microphone method (insert voltage technique)	123.917       0.06         ermined SPL should be reported with three decimals. The pilot laboratory will round it for two decimals.         requency, Hz       Total harmonic distortion, %       fotal distortion + noise, % (measured over a bandwidth of 22.4 Hz to 22.4         d       Uncertainty (k = 2)       Measured       Uncertainty (k = 2)         0.01       0.393       0.06       0.762       0.06         same defrequency, THD and TD-N should be reported with one decimal extra than their respective uncertainty. The pilot laboratory will ro       same decimals number of the uncertainty.         y deviations from IEC 60942:2017 (Periodic tests) in the technical procedure used?       transpective and DT-N should be reported with one decimal extra than their respective uncertainty. The pilot laboratory will ro         y deviation for IEC 60942:2017 (Periodic tests) in the technical procedure used?       transpective and DT-N should be reported with one decimal extra than their respective uncertainty. The pilot laboratory will ro         y deviation for IEC 60942:2017 (Periodic tests) in the technical procedure used?       transpective and DT-N should be reported with one accord and the extra than their respective uncertainty.         y deviation for the pistonphone during the calibration? Was it horizontal? Was it vertical with the acvity up? Was it vertical with the cavit pointing upwards.       terethod used to measure the generated sound pressure level? Did you use the microphone method (insert voltage technique) or another remeth with 3 microphones 152P.         reference measurement microp	sound pressure in	Deteri	mined	orume correspond	Uncert	tainty ( $k = 2$ )
P.S.: The determined SPL should be reported with three decimals. The pilot laboratory will round it for two decimals.         Frequency, Hz       Total harmonic distortion, %       Total distortion + noise, % (measured over a bandwidth of 22.4 Hz)         Measured       Uncertainty (k = 2)       Measured       Uncertainty (k = 2)         251.172       0.01       0.393       0.06       0.762       0.06         P.S.: The measured frequency, THD and TD-N should be reported with one decimal extra than their respective uncertainty. The pilot laboratory them for the same decimals number of the uncertainty.         Are there any deviations from IEC 60942:2017 (Periodic tests) in the technical procedure used?         Measurements are performed using an automated system which sequencially measures SPL, frequency and DT. Overall time used in measurer reported in here.         What was the orientation of the pistonphone during the calibration? Was it horizontal? Was it vertical with the cavity up? Was it vertical with the down?         The pistonphone was in vertical position with the cavity pointing upwards.         What was the method used to measure the generated sound pressure level? Did you use the microphone method (insert voltage technique) or one?         Direct measurement with 3 microphone's type used? Did you use a LS1P or another one?         Retail Number       1734027         Load Volume Corr.       0.278         dB	ermined SPL should be reported with three decimals. The pilot laboratory will round it for two decimals.           requency, Hz         Total harmonic distortion, %         Total distortion + noise, % (measured over a bandwidth of 22.4 Hz to 22.4           d         Uncertainty (k = 2)         Measured         Uncertainty (k = 2)           a         0.0         0.393         0.66         0.762         0.06           asured frequency, THD and TD+N should be reported with one decimal extra than their respective uncertainty. The pilot laboratory will ro         same decimals number of the uncertainty.           y deviations from IEC 60942:2017 (Periodic tests) in the technical procedure used?         trap set of the asurement period in Clauses A.5.5.1, A.5.7.1 and A.5.8.1 is shorter than the actual time used in measurements ere.           orientation of the pistonphone during the calibration? Was it horizontal? Was it vertical with the cavity up? Was it vertical with the cavit up?           orientation of the pistonphone during the calibration? Was it horizontal? Was it vertical with the cavit up?           orientation of the pistonphone during the calibration? Was it horizontal? Was it vertical with the cavit up?           reference measurement microphone?           reference measurement microphone?           sizeP, type 4150.           value of the correction applied to the measured sound pressure level:           uumee corresponding to the used microphone?           r         1734027           r         0.0004		123	.917			0.06
Frequency, Hz         Total harmonic distortion, %         Total distortion + noise, % (measured over a bandwidth of 22.4 Hz)           Measured         Uncertainty (k = 2)         Measured         Uncertainty (k = 2)         0.06         0.762         0.06           P.S.: The measured frequency, THD and TD-N should be reported with one decimal extra than their respective uncertainty. The pilot laboratory them for the same decimals number of the uncertainty.         0.06         0.762         0.06           Are there any deviations from IEC 60942:2017 (Periodic tests) in the technical procedure used?         Measurements are performed using an automated system which sequencially measures SPL, frequency and DT. Overall time to determine the traparameters is 90 seconds. Specified measurement period in Clauses A.5.5.1, A.5.7.1 and A.5.8.1 is shorter than the actual time used in measurer reported in here.           What was the orientation of the pistonphone during the calibration? Was it horizontal? Was it vertical with the cavity up? Was it vertical with the down?           The pistonphone was in vertical position with the cavity pointing upwards.           What was the method used to measure the generated sound pressure level? Did you use the microphone method (insert voltage technique) or one?           Briel & Kiger's LS2P, type 4160.           What was the reference measurement microphone? Stype used? Did you use a LS1P or another one?           Briel Number         1734027           Load Volume Corr.         0.2968         dB             Microphone Temerature envinnemental	requency, Hz Total harmonic distortion, % Total distortion + noise, % (measured over a bandwidth of 22.4 Hz to 22.4 d Uncertainty (k = 2) Measured Uncertainty (k = 2) Measured Uncertainty (k = 2) 0.01 0.393 0.06 0.762 0.762 0.06 0.762 0.762 0.06 0.762 0.762 0.06 0.762 0.762 0.06 0.762 0.762 0.06 0.762 0.762 0.06 0.762 0.762 0.06 0.762 0.762 0.06 0.762 0.762 0.06 0.762 0.762 0.06 0.762 0.762 0.06 0.762 0.762 0.06 0.762 0.762 0.06 0.762 0.762 0.06 0.762 0.762 0.76 0.77 0.71 0.71 0.72 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7 0.7	P.S.: The determin	ed SPL should be re	ported with three d	lecimals. The pilot	aboratory will round it for two decin	nals.
Measured         Uncertainty (k = 2)         Measure	International structure         International structure         International structure           i         0.01         0.393         0.06         0.762         0.06           surref requency, TIba and TOHK should be reported with one decimal extra than their respective uncertainty. The pilot laboratory will rore same decimals number of the uncertainty.         0.06         0.762         0.06           surref requency, TIba and TOHK should be reported with one decimal extra than their respective uncertainty. The pilot laboratory will rore same decimals number of the uncertainty.         0.06         0.762         0.06           y deviations from IEC 60942:2017 (Periodic tests) in the technical procedure used?         1.11111111111111111111111111111111111	Freque	ency, Hz	Total harmoni	ic distortion. %	Total distortion + noise. % (measure	d over a bandwidth of 22.4 Hz to 22.4
251.172       0.01       0.383       0.06       0.762       0.06         P.S.: The measured frequency. THD and TD+N should be reported with one decimal extra than their respective uncertainty. The pilot laboratory them for the same decimals number of the uncertainty.       0.06       0.762       0.06         P.S.: The measured frequency. THD and TD+N should be reported with one decimal extra than their respective uncertainty.       The pilot laboratory them for the same decimals number of the uncertainty.         Are there any deviations from IEC 60942:2017 (Periodic tests) in the technical procedure used?       Measurements are performed using an automated system which sequencially measures SPL, frequency and DT. Overall time to determine the t parameters is 90 seconds. Specified measurement period in Clauses A.S.S.J. A.S.7.1 and A.S.8.1 is shorter than the actual time used in measurer reported in here.         What was the orientation of the pistonphone during the calibration? Was it horizontal? Was it vertical with the cavity up? Was it vertical with the down?         The pistonphone was in vertical position with the cavity pointing upwards.         What was the method used to measure the generated sound pressure level? Did you use the microphone method (insert voltage technique) or one?         Briel & Kjær's LS2P, type 4160.         What was the reference measurement microphone's type used? Did you use a LS1P or another one?         Briel & Kjær's LS2P, type 4160.         What was the value of the correction applied to the measured sound pressure level:         0 for lad volume corre.gozed       d8	0.01     0.393     0.06     0.762     0.06       saured frequency, THD and TD+N should be reported with one decimal extra than their respective uncertainty. The pilot laboratory will ro       same decimals number of the uncertainty.       y deviations from IEC 60942:2017 (Periodic tests) in the technical procedure used?       tts are performed using an automated system which sequencially measures SPL, frequency and DT. Overall time to determine the three       s 00 seconds. Specified measurement period in Clauses A.5.5.1, A.5.7.1 and A.5.8.1 is shorter than the actual time used in measurements tere.       e orientation of the pistonphone during the calibration? Was it horizontal? Was it vertical with the cavity up? Was it vertical with the cavit up? Was it vertical	Measured	Uncertainty $(k = 2)$	Measured	Uncertainty $(k = 2)$	Measured	Uncertainty $(k = 2)$
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Are there any deviations from IEC 60942:2017 (Periodic tests) in the technical procedure used? Weasurements are performed using an automated system which sequencially measures SPL, frequency and DT. Overall time to determine the to parameters is 90 seconds. Specified measurement period in Clauses A.5.5.1, A.5.7.1 and A.5.8.1 is shorter than the actual time used in measurer reported in here. What was the orientation of the pistonphone during the calibration? Was it horizontal? Was it vertical with the cavity up? Was it vertical with the form? The pistonphone was in vertical position with the cavity pointing upwards. What was the method used to measure the generated sound pressure level? Did you use the microphone method (insert voltage technique) or one? Direct measurement with 3 microphones LS2P. What was the reference measurement microphone's type used? Did you use a LS1P or another one? Briel & Kjær's LS2P, type 4160. What was the value of the correction applied to the measured sound pressure level: a) for load volume corresponding to the used microphone? Berial Number 1734002 Load Volume Corr. 0.2978 dB b) for the reference environmental conditions? Microphone Temperature + Humidity Correction: 0.0004 Microphone Temperature + Humidity Correction: 0.0003 dB Microphone Temperature + Humidity Correction: 0.0003 dB Microphone Pressure Correction: 0.0003 MB Microphone Pressure Correction: 0.0003 MB Microphone Pressure Correction: 0.0003 MB Microphone Pressure Correction: 0.0003 MB Microphone Pressure Correction: 0.0003 MB Microphone Pressure Correction: 0.0005 MC B MC Direction Correction: 0.0005 MC B MC Direction Correction: 0.0005 MC B MC Direction Corr	y deviations from IEC 60942:2017 (Periodic tests) in the technical procedure used?  tts are performed using an automated system which sequencially measures SPL, frequency and DT. Overall time to determine the three s 90 seconds. Specified measurement period in Clauses A.5.5.1, A.5.7.1 and A.5.8.1 is shorter than the actual time used in measurements tere.  a orientation of the pistonphone during the calibration? Was it horizontal? Was it vertical with the cavity up? Was it vertical with the cavit one was in vertical position with the cavity pointing upwards.  a method used to measure the generated sound pressure level? Did you use the microphone method (insert voltage technique) or another rement with 3 microphones LS2P.  a reference measurement microphone's type used? Did you use a LS1P or another one?  s LS2P, type 4160.  a value of the correction applied to the measured sound pressure level: liume corresponding to the used microphone?  r 1734027 Load Volume Corr. 0.2978 dB r 1598020 Load Volume Corr. 0.295 dB r 1598020 Load Volume Corr. 0.295 dB remece environmental conditions?  member 1734027 Doubd Volume Corr. 0.295 dB ressure Correction: 0.0004 dB ressure Correction: 0.0005 dB ressure Correction: 0.0002 dB ressure Correction: 0.0002 dB ressure Correction: 0.0009 dB ressure Correction: 0.0009 dB ressure Correction: 0.0009 dB ressure Correction: 0.0009 dB ressure Aumidity Correction: 0.0009 dB ressure Correction: 0.0009 dB ressure Correction: 0.0009 dB ressure Correction: 0.0009 dB ressure Label Correction: 0.0009 dB ressure Correction:	them for the same	e decimais number o	or the uncertainty.			
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What was the orientation of the pistonphone during the calibration? Was it horizontal? Was it vertical with the cavity up? Was it vertical with the down? The pistonphone was in vertical position with the cavity pointing upwards. What was the method used to measure the generated sound pressure level? Did you use the microphone method (insert voltage technique) or one? Direct measurement with 3 microphones LS2P. What was the reference measurement microphone's type used? Did you use a LS1P or another one? Brüel & Kjær's LS2P, type 4160. What was the value of the correction applied to the measured sound pressure level: a) for load volume corresponding to the used microphone? Serial Number 1734027 Load Volume Corr. 0.2978 dB Serial Number 1734011 Load Volume Corr. 0.295 dB b) for the reference environmental conditions? Mic. Serial Number 1734027 0.0004 dB Microphone Pressure Correction: 0.0002 dB Distonphone Temperature + Humidity Correction: 0.0003 dB Microphone Temperature + Humidity Correction: 0.0003 dB Microphone Temperature + Humidity Correction: 0.0009 dB	e orientation of the pistonphone during the calibration? Was it horizontal? Was it vertical with the cavity up? Was it vertical with the cavit toone was in vertical position with the cavity pointing upwards. e method used to measure the generated sound pressure level? Did you use the microphone method (insert voltage technique) or another irrement with 3 microphones LS2P. e reference measurement microphone's type used? Did you use a LS1P or another one? s LS2P, type 4160. e value of the correction applied to the measured sound pressure level: ilume corresponding to the used microphone? er 1734027 Load Volume Corr. 0.2978 dB er a 1698020 Load Volume Corr. 0.2956 dB erence environmental conditions? umber 1734027 0.0006 dB meperature + Humidity Correction: -0.0006 dB meperature + Humidity Correction: -0.0006 dB imperature + Humidity Correction: -0.0003 dB meperature + Humidity Correction: -0.0004 dB meperature + Humidity Correction: -0.0003 dB meperature + Humidity Correction: -0.0003 dB meperature + Humidity Correction: -0.0003 dB meperature + Humidity Correction: -0.0004 dB meperature + Humidity Correction: -0.0003 dB meperature + Humidity Correction: -0.0003 dB meperature + Humidity Correction: -0.0003 dB meperature + Humidity Correction: -0.0004 dB meperature + Humidity Correction: -0.0004 dB meperature + Humidity Correction: -0.0003 dB meters Correction: -0.0004 dB meters Correction: -0.0004 dB meters Correction: -0.0004 dB meters Corection: -0.0004 dB meters Correction: -0.0004 dB m	reported in here.			III clauses A.S.S.1,	A.5.7.1 and A.5.8.1 is shorter than the	e actual time used in measurements
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Microphone Pressure Correction: 0,0003 dB Microphone Pressure + Humidity Correction: -0.0009 dB Microphone + Humidity Correction:	essure Correction:         0.0003         dB	What was the orie down? The pistonphone v What was the met one? Direct measureme What was the refe Brüel & Kjær's LS2 What was the valu a) for load volume Serial Number Serial Number Serial Number Serial Number Di for the reference Microphone Pressur Wicrophone Pressur Pistonphone Temper	ntation of the pistor was in vertical positi hod used to measur ent with 3 microphor rence measurement P, type 4160. e of the correction a corresponding to th 1734027 1698020 1734011 e environmental co r e correction: ature + Humidity Corre ature + Humidity Corre	aphone during the c on with the cavity p e the generated south the subscription of the south test subscription of the south test subscription of the south polied to the meass the used microphone's type polied to the meass the used microphone's type to the	alibration? Was it i vointing upwards. und pressure level? e used? Did you use ured sound pressu ? 0.2978 0.2968 0.295 0.0004 -0.0006 0.0022 -0.0050	A.5.7.1 and A.5.8.1 is shorter than the composition of the composition	e actual time used in measurements witry up? Was it vertical with the cavit d (insert voltage technique) or anothe d d (insert voltage technique) or anothe
Microphone Temperature + Humidity Correction: -0.0009 dB	Imperature + Humidity Correction:         -0.0009         dB	What was the orie down? The pistonphone v What was the met one? Direct measureme What was the refe Brüel & Kjær's LS2 What was the valu a) for load volume Serial Number Serial Number Serial Number Serial Number Serial Number Di for the reference Miccophone Pressur Miccophone Pressur Pistonphone Temper Pistonphone Temper	ntation of the pistor was in vertical positi hod used to measur ent with 3 microphor rence measurement P, type 4160. e of the correction a corresponding to th 1734027 1698020 1734011 e environmental co r e Correction: ature + Humidity Corre e correction: ature + Humidity Corre	aphone during the c on with the cavity p e the generated sources the scale of the sources escale of the sources pipelied to the meas the used microphone's type pipelied to the meas the used microphone's type pipelied to the meas the used microphone's type to the sources to the sources the sour	alibration? Was it i pointing upwards. und pressure level? e used? Did you use ured sound pressu ? 0.2978 0.2958 0.295 0.0004 -0.0006 0.0022 -0.0050	A.5.7.1 and A.5.8.1 is shorter than the component of the	e actual time used in measurements
	ressure Correction: 0.0019 dB emperature + Humidity Correction Correction: -0.0049 dB emperature + Humidity Correction: -0.0049 emperature + Humidity Co	What was the orie down? The pistonphone v What was the met one? Direct measureme What was the refe Brüel & Kjær's LS2 What was the valu a) for load volume Serial Number Serial Number Serial Number Serial Number Microphone Pressur Pistonphone Pressur Pistonphone Temper Pistonphone Temper Pistonphone Temper	ntation of the pistor was in vertical positi hod used to measur ent with 3 microphor rence measurement P, type 4160. e of the correction a corresponding to th 1734027 1698020 1734011 e environmental co r e Correction: ature + Humidity Corree ature + Humidity Corree ature + Humidity Corree or r e Correction:	nphone during the o on with the cavity p e the generated sou nes LS2P. t microphone's type used microphone Load Volume Corr. Load Volume Corr. Load Volume Corr. Load Volume Corr. Load Volume Corr. ction: ction:	alibration? Was it i pointing upwards. und pressure level? e used? Did you use ured sound pressu e? 0.2978 0.2958 0.295 0.0004 -0.0006 0.0022 -0.0050 0.0003	A.5.7.1 and A.5.8.1 is shorter than the calculation of the calculation	e actual time used in measurements invity up? Was it vertical with the cavit d (insert voltage technique) or anothe d (insert voltage t
Pistonphone Pressure Correction: 0.0019 dB	emperature + Humidity Correction Correction: -0.0049 dB	What was the orie down? The pistonphone v What was the met one? Direct measureme What was the refe Brüel & Kjær's LS2 What was the valu J for load volume Serial Number Serial Number Serial Number b) for the reference Microphone Pressur Vistonphone Pressur Pistonphone Temper Stonphone Temper	ntation of the pistor was in vertical positi hod used to measur ent with 3 microphor rence measurement P, type 4160. e of the correction a corresponding to th corresponding to th correction: ature + Humidity Corre e Correction: ature + Humidity Corre e correction: ature + Humidity Corre e correction: ature + Humidity Corre	aphone during the o on with the cavity p e the generated south the LS2P. It microphone's type pplied to the meas the used microphone Load Volume Corr. Load Volume Corr.	alibration? Was it i pointing upwards. und pressure level? e used? Did you use ured sound pressu ? 0.2978 0.295 0.295 0.0004 -0.0006 0.0022 -0.00050 0.0003 -0.0003 -0.0009	A.5.7.1 and A.5.8.1 is shorter than the component of the	e actual time used in measurements avity up? Was it vertical with the cavit d (insert voltage technique) or anothe d (insert voltage technique) or anothe d (insert voltage technique) or anothe d d (insert voltage technique) or anothe d d d d d d d d d d d d d d d d d d d
Pistonphone Temperature + Humidity Correction Correction: -0.0049 dB	mber 1734011	What was the orie down? The pistonphone v What was the met one? Direct measureme What was the refe Brüel & Kjær's LS2 What was the valu a) for load volume Serial Number Serial Number Serial Number Serial Number Serial Number D) for the reference Microphone Pressur Pistonphone Pressur Vicrophone Temper Pistonphone Pressur Vicrophone Pressur	ntation of the pistor was in vertical positi hod used to measur ent with 3 microphor rence measurement P, type 4160. e of the correction a corresponding to th 1734027 16688020 1734011 e correction: ature + Humidity Corre e Correction: ature + Humidity Corre c Correction: ature + Humidity Corre e correction: ature + Humidity Corre	aphone during the o on with the cavity p e the generated south the second south the second south the second south the second souther south the second south the second south the	alibration? Was it i pointing upwards. und pressure level? ured sound pressu e used? Did you use ured sound pressu ? 0.2978 0.2978 0.2968 0.295 0.0004 -0.0006 0.0022 -0.00050 -0.0000 0.0003 -0.0009 0.0019	A.5.7.1 and A.5.8.1 is shorter than the calculation of the calculation	e actual time used in measurements avity up? Was it vertical with the cavit d (insert voltage technique) or anothe d (insert voltage technique) or anothe d (insert voltage technique) or anothe d d (insert voltage technique) or anothe d d d d d d d d d d d d d d d d d d d

Mineralizera Terrarative a Unablita Consettana		0.0001	d D				
Microphone Temperature + Humidity Correction:		0.0001	aB				
Pistonphone Pressure Correction:		0.0022	dB				
Pistonphone Temperature + Humidity Correction Correction:		-0.0058	dB				
What was the met	hod used to measure	ed the total disto	tion + noise? Did	you use a rejection f	ilter device (disto	rtion factor me	eter) or a FFT analyze
what was the met	nou useu to meusur		don i noise, biu	you use a rejection i	inter acvice faisto	reformation me	tery of a first analyze
the second state in the second state	take attack from the second second						
Hewlett Packard D	istortion Analyser, n	nodel 8903E.					
Hewlett Packard D	istortion Analyser, n	nodel 8903E.					
Hewlett Packard E	istortion Analyser, n	nodel 8903E.	idget The ISO do	cument "Evaluation	of measurement d	ata - Guide to	the expression of
Hewlett Packard D	istortion Analyser, n get to submit your fi	nodel 8903E.	udget. The ISO do	ocument "Evaluation (	of measurement d	ata - Guide to	the expression of
Hewlett Packard D Please, do not for, uncertainty meas	istortion Analyser, n get to submit your fin urement" shall be u	nodel 8903E. nal uncertainty bu sed as the referer	idget. The ISO do nce document.	ocument "Evaluation	of measurement d	ata - Guide to	the expression of
Hewlett Packard D Please, do not for uncertainty meas	istortion Analyser, n get to submit your fii urement" shall be u	nodel 8903E. nal uncertainty bu sed as the referer	idget. The ISO do nce document.	ocument "Evaluation	of measurement d	ata - Guide to	the expression of
Hewlett Packard E Please, do not for uncertainty meas Do you have any a	istortion Analyser, n get to submit your fir urement" shall be u dditional informatio	nodel 8903E. nal uncertainty bu sed as the referer n that you would	udget. The ISO do nce document. like to share to th	e pilot laboratory?	of measurement d	ata - Guide to	the expression of
Hewlett Packard E Please, do not for uncertainty meas Do you have any a	istortion Analyser, n get to submit your fir urement" shall be u dditional informatio	nodel 8903E. nal uncertainty bu sed as the referer n that you would	udget. The ISO do nce document. like to share to th	ocument "Evaluation of the pilot laboratory?	of measurement c	ata - Guide to	the expression of
Hewlett Packard D Please, do not for, uncertainty meas Do you have any a	istortion Analyser, n get to submit your fii urement" shall be u dditional informatio	nodel 8903E. nal uncertainty bu sed as the referer n that you would	udget. The ISO do nce document. like to share to th	ne pilot laboratory?	of measurement o	lata - Guide to	the expression of
Hewlett Packard D Please, do not for, uncertainty meas Do you have any a	istortion Analyser, n get to submit your fii urement" shall be u dditional informatio	nodel 8903E. nal uncertainty bu sed as the referen n that you would	idget. The ISO do nee document. like to share to th	e pilot laboratory?	of measurement d	lata - Guide to	the expression of
Hewlett Packard D Please, do not for uncertainty meas Do you have any a	istortion Analyser, n get to submit your fii urement" shall be u dditional informatio	nodel 8903E. nal uncertainty bu sed as the referer n that you would	udget. The ISO do nce document. like to share to th	e pilot laboratory?	of measurement o	lata - Guide to	the expression of
Hewlett Packard D Please, do not for, uncertainty meas Do you have any a	istortion Analyser, n get to submit your fii urement" shall be u dditional informatio	nodel 8903E. nal uncertainty bu sed as the referer n that you would	udget. The ISO do nce document. like to share to th	cument "Evaluation of the pilot laboratory?	of measurement d	lata - Guide to	the expression of
Hewlett Packard E Please, do not for, uncertainty meas Do you have any a	istortion Analyser, n get to submit your fil urement" shall be u dditional informatio	nodel 8903E. nal uncertainty bu sed as the referer n that you would	idget. The ISO do ince document. like to share to th	ecument "Evaluation of the pilot laboratory?	of measurement o	lata - Guide to	the expression of

# **B.5 INTI**

	ufactured by Brüel and	Kjaer, type 4228, se	rial number 2836183, with its one-inch	to half-inch adaptor type DP 0776
Results obtained wit	h the one-inch to half-i	nch adaptor type DI	0776, i.e. using a half-inch reference	measurement microphone
National Metrology Institute	11	NTI	]	
Period of the calibration Air temperature (°C) Static pressure (kPa) Relative humidity (%)				
01/03/19 to 21/03/19	20,1	to 24,9	100,2 to 102,1	44 to 64
Sound pressure level, dB re, 20 u	Pa (corrected for load v	olume correspond	ing to the microphone used and for the	e reference environmental conditions
D	etermined		Uncertai	nty (k = 2)
P.S.: The determined SPL should b	123.970 e reported with three of	decimals. The pilot	0 laboratory will round it for two decima	.08 Is.
Frequency, Hz	Total harmon	ic distortion, %	Total distortion + noise, % (measured	over a bandwidth of 22.4 Hz to 22.4 kH
Measured Uncertainty (k	= 2) Measured	Uncertainty ( $k = 2$	Measured	Uncertainty (k = 2)
them for the same decimals num	ber of the uncertainty.			
Vertical position, cavity down. What was the method used to me	asure the generated so	und pressure level		
Insert voltage technique method What was the reference measure 2 (two) type 4180 LS2P microphon	was used. ment microphone's type es.	e use? Did you used	a LS2P or another one?	(insert voltage technique) or another
Insert voltage technique method What was the reference measure 2 (two) type 4180 LS2P microphon What was the value of the correct	was used. ment microphone's types. ion applied to the meas	e use? Did you used	i a LS2P or another one? re level:	(insert voltage technique) or another
Insert voltage technique method What was the reference measure 2 (two) type 4180 LS2P microphon What was the value of the correct a) for load volume corresponding	was used. ment microphone's types. ion applied to the meas to the used microphon	e use? Did you used ured sound pressu a?	i a LS2P or another one? re level:	(insert voltage technique) or another
Insert voltage technique method What was the reference measure 2 (two) type 4180 LS2P microphon What was the value of the correct a) for load volume corresponding + 0,08 b) for the reference environment	was used. ment microphone's type es. ion applied to the meas to the used microphone al conditions?	e use? Did you used ured sound pressu a?	l a LS2P or another one?	(insert voltage technique) or another
Insert voltage technique method What was the reference measure 2 (two) type 4180 LS2P microphon What was the value of the correct a) for load volume corresponding +0,08 b) for the reference environment All ambient corrections are refer individual corrections were applie 3.2.1 (eq. 3.3) for ambient barome made to decrease microphone so	was used. ment microphone's type es. ion applied to the meas to the used microphone al conditions? ed to normative refere ed on the complete calii tric pressure. The hum urce/switch attenuation	e use? Did you used sured sound pressu e? nce conditions. As pration period. This dity correction was h (Max. value 0,002	i a LS2P or another one? re level: bur laboratory couldn't control the amb corrections were made using pistonph -0,002 dB to all measuements. An amp db).	(insert voltage technique) or another ient barometric pressure, different ione user's manual, chapter 3, item lificaction correction was already
Insert voltage technique method What was the reference measure 2 (two) type 4180 LS2P microphon What was the value of the correct a) for load volume corresponding + 0,08 b) for the reference environment All ambient corrections are referr individual corrections were applie 3.2.1 (eq. 3.3) for ambient barome made to decrease microphone so What was the method used to me NA	was used. ment microphone's type es. ion applied to the meas to the used microphone al conditions? ed to normative refere ed on the complete calil tric pressure. The humi urce/switch attenuation asured the total distort	e use? Did you used sured sound pressu e? nce conditions. As a pration period. This dity correction was n (Max. value 0,002 ion + noise? Did yo	i a LS2P or another one? re level: our laboratory couldn't control the amb corrections were made using pistonph -0,002 dB to all measuements. An amp db).	(insert voltage technique) or another vient barometric pressure, different ione user's manual, chapter 3, item lificaction correction was already n factor meter) or a FFT analyzer?
Insert voltage technique method What was the reference measure 2 (two) type 4180 LS2P microphon What was the value of the correct a) for load volume corresponding + 0,08 b) for the reference environment All ambient corrections are referr individual corrections were applie 3.2.1 (eq. 3.3) for ambient barome made to decrease microphone so What was the method used to me NA Please, do not forget to submit ye uncertainty measurement" shall	was used. ment microphone's type es. ion applied to the meas to the used microphone al conditions? ed to normative refere do n the complete calil tric pressure. The hum urce/switch attenuation asured the total distort ur final uncertainty buc be used as the reference	e use? Did you used sured sound pressu e? nce conditions. As oration period. This didty correction was n (Max. value 0,002 ion + noise? Did yo lget. The ISO docurse document.	i a LS2P or another one? re level: bur laboratory couldn't control the amb corrections were made using pistonph -0,002 dB to all measuements. An amp db). u use a rejection filter device (distortion ment "Evaluation of measurement data	(insert voltage technique) or another ient barometric pressure, different ione user's manual, chapter 3, item lificaction correction was already n factor meter) or a FFT analyzer? - Guide to the expression of

	Artef	act: Pistonphone ma	nufactured by Brü	el and Kjaer, type 4228, serial number	2836183
		Results obtained	using an <b>one-inch</b>	reference measurement microphone	!
National Met	rology Institute	IN	ТІ		
Period of th	e calibration	Airtemper	rature (°C)	Static pressure (kPa)	Relative humidity (%)
28/02/19 to 21/03/19         20,4 to 24,4         100,5 to 102,1         44 to 63					
Sound pressure level dB re 20 uPa (corrected for load volume corresponding to the microphone used and for the reference environmental conditions)					
Sound pressure in	Deter	rmined	ordine correspond	Uncert	ainty ( $k = 2$ )
P.S.: The determin	123 ied SPL should be re	3.922 eported with three d	ecimals. The pilot	laboratory will round it for two decim	0.07 als.
Freque	ency, Hz	Total harmonic	c distortion, %	Total distortion + noise, % (measured	d over a bandwidth of 22.4 Hz to 22.4 kl
Measured	Uncertainty $(k = 2)$	Measured	Uncertainty (k = 2	) Measured	Uncertainty $(k = 2)$
Are there any devi	iations from IEC 609	42:2017 (Periodic tes	ts) in the technic	al procedure used?	
Vertical position, of What was the met one? Insert voltage tech What was the refe 3 (three) type 4160 What was the valu a) for load volume + 0,23 dB (this valu b) for the reference individual correcti 3.2.1 (eq. 3.3) for a made to decrease	avity down. hod used to measur inique method was rence measuremen DLS1P microphones e of the correction corresponding to ti e was calculated wi e environmental co tions are referred t ons were applied o imbient barometric microphone source	re the generated sou used. It microphone's type were used. applied to the measu he used microphone th the measured rea onditions? o normative referen n the complete calib pressure. The humic //switch attenuation	used? Did you us ured sound pressu ? Il and equivalent r ice conditions. As ration period. Thi fify correction wa (Max. value 0,002	? Did you use the microphone method e a LS1P or another one? re level: microphones frontal volume, 250Hz). our laboratory couldn't control the arr s corrections were made using pistong s -0,002 dB to all measuements. An am db).	l (insert voltage technique) or another bient barometric pressure, different bione user's manual, chapter 3, item plificaction correction was already
	hod used to measu	red the total distortion	on + noise? Did yo	u use a rejection filter device (distorti	ion factor meter) or a FFT analyzer?
What was the met	tet to submit your f	inal uncortainty bud	tot. The ISO doors	ment "Evaluation of measurement dat	ta - Guide to the expression of
What was the met NA Please, do not forg uncertainty meas	get to submit your f urement" shall be u	inal uncertainty budg used as the reference	get. The ISO docu e document.	ment "Evaluation of measurement dat	ta - Guide to the expression of

### **B.6 LACOMET**

	stonphone manufact	ured by Brüel and k	(jaer, type 4228, se	erial number 2836183, with its one-inch	to half-inch adaptor type DP 0776
Resu	Its obtained with the	one-inch to half-ir	nch adaptor type D	P 0776, i.e. using a half-inch reference	measurement microphone
National Metrology Institute LACOMET					
Period of the calibration Air temperature (°C) April 8 to April 19, 2019 22,1		Static pressure (kPa)	Relative humidity (%)		
				1	1
Sound pressure level, dB re. 20 µPa (corrected for load volume correspondi			olume correspond	ling to the microphone used and for the	e reference environmental conditions
	Deterr	nined		Uncertai	inty (k = 2)
P.S.: The determi	123. ned SPL should be rep	888 ported with three d	lecimals. The pilot	0. laboratory will round it for two decima	059 Is.
<b>F</b> =		Tatal bases and			
Measured	lency, Hz	Iotal harmoni Measured	Ic distortion, %	Neasured	Over a bandwidth of 22.4 Hz to 22.4 Kl
251.174	0.03	0.584	0.2	0.960	0.4
No with respect t	o IEC 60942:2003		stsj in tre technic	al procedure used?	
No with respect t What was the ori down? Was it vertical wi What was the me	o IEC 60942:2003 entation of the piston th the cavity up thod used to measure	phone during the c	calibration? Was it	horizontal? Was it vertical with the cav	ity up? Was it vertical with the cavity
No with respect t What was the ori down? Was it vertical wi What was the me one?	o IEC 60942:2003 entation of the piston th the cavity up thod used to measure bnique	phone during the o	calibration? Was it	horizontal? Was it vertical with the cavi	ity up? Was it vertical with the cavity (insert voltage technique) or another
No with respect t What was the ori down? Was it vertical wi What was the me one? Insert voltage tec	o IEC 60942:2003 entation of the piston th the cavity up thod used to measure hnique	phone during the o	und pressure level	horizontal? Was it vertical with the cav	ity up? Was it vertical with the cavity (insert voltage technique) or another
No with respect t What was the orid down? Was it vertical wi What was the me one? Insert voltage tec What was the ref	o IEC 60942:2003 entation of the piston th the cavity up thod used to measure hnique erence measurement	phone during the c	und pressure level	horizontal? Was it vertical with the cav Porizontal? Was it vertical with the cav Poid you use the microphone method d a LS2P or another one?	ity up? Was it vertical with the cavity (insert voltage technique) or another
No with respect t What was the ori down? Was it vertical wi What was the me one? Insert voltage tec What was the refe LS2P Bruel & Kjae	o IEC 60942:2003 entation of the piston th the cavity up thod used to measure hnique erence measurement er 4180	phone during the o	und pressure level	horizontal? Was it vertical with the cav ? Did you use the microphone method d a LS2P or another one?	ity up? Was it vertical with the cavity (insert voltage technique) or another
No with respect t What was the ori down? Was it vertical wi What was the me one? Insert voltage teo What was the ref LS2P Bruel & Kjae What was the val	o IEC 60942:2003 entation of the piston th the cavity up thod used to measure hnique erence measurement er 4180 ue of the correction a	phone during the operated source in the generated sour	und pressure level	horizontal? Was it vertical with the cav ? Did you use the microphone method i d a LS2P or another one?	ity up? Was it vertical with the cavity (insert voltage technique) or another
No with respect t What was the ori down? Was it vertical wi What was the me one? Insert voltage tec What was the ref LS2P Bruel & Kjae What was the val a) for load volum Bruel & Kjaer 418	o IEC 60942:2003 entation of the piston th the cavity up thod used to measure hnique erence measurement or 4180 ue of the correction a e corresponding to th 00 = 0.08 dB	phone during the operated sources in the generated sources in the gener	und pressure level e use? Did you use ured sound pressu	horizontal? Was it vertical with the cav ? Did you use the microphone method i d a LS2P or another one?	ity up? Was it vertical with the cavity (insert voltage technique) or another
No with respect t What was the ori down? Was it vertical wi What was the me one? Insert voltage tec What was the reff LS2P Bruel & Kjae What was the val a) for load volum Bruel & Kjaer 418 b) for the referen	o IEC 60942:2003 entation of the piston th the cavity up thod used to measure hnique erence measurement er 4180 ue of the correction a e corresponding to th 00 = 0,08 dB ce environmental cor	phone during the c e the generated sou microphone's type pplied to the meas e used microphone nditions?	und pressure level e use? Did you use ured sound pressu	horizontal? Was it vertical with the cav ? Did you use the microphone method i d a LS2P or another one?	ity up? Was it vertical with the cavity (insert voltage technique) or another
No with respect t What was the ori down? Was it vertical wi What was the me one? Insert voltage tec What was the ref- LS2P Bruel & Kjaer What was the val a) for load volum Bruel & Kjaer 418 b) for the referen -1,212 dB	o IEC 60942:2003 entation of the piston th the cavity up thod used to measure hnique erence measurement er 4180 ue of the correction a e corresponding to th 0 = 0,08 dB ce environmental cor	phone during the operated sources of the generated sources of the gener	und pressure level e use? Did you use ured sound pressu	horizontal? Was it vertical with the cav ? Did you use the microphone method i d a LS2P or another one?	ity up? Was it vertical with the cavity (insert voltage technique) or another
No with respect t What was the orig down? Was it vertical wi What was the me one? Insert voltage tec What was the ref LS2P Bruel & Kjae What was the val a) for load volum Bruel & Kjaer 418 b) for the referen -1,212 dB What was the me	o IEC 60942:2003 entation of the piston th the cavity up thod used to measure hnique erence measurement er 4180 ue of the correction a e corresponding to th 0 = 0,08 dB cc environmental cor thod used to measure	phone during the operated sources of the generated sources of the gener	alibration? Was it und pressure level e use? Did you use ured sound pressu a? ion + noise? Did you	horizontal? Was it vertical with the cav Poid you use the microphone method i d a LS2P or another one? ire level: bu use a rejection filter device (distortion)	ity up? Was it vertical with the cavity (insert voltage technique) or another
No with respect t What was the original down? Was it vertical with What was the me one? Insert voltage tec What was the refe LS2P Bruel & Kjaer What was the val a) for load volum Bruel & Kjaer 418 b) for the referen -1,212 dB What was the me FFT analyzer ( PC	o IEC 60942:2003 entation of the piston th the cavity up thod used to measure hnique erence measurement er 4180 ue of the correction a e corresponding to th to = 0,08 dB cc environmental cor thod used to measure + software ARTA)	phone during the operated source in the generated sour	alibration? Was it und pressure level e use? Did you use ured sound pressu e? ion + noise? Did yo	horizontal? Was it vertical with the cav Point of the microphone method is a LS2P or another one? In level: In level:	ity up? Was it vertical with the cavity (insert voltage technique) or another
No with respect t What was the original down? Was it vertical wi What was the me one? Insert voltage tec What was the ref LS2P Bruel & Kjae What was the val a) for load volum Bruel & Kjaer 418 b) for the referen -1,212 dB What was the me FFT analyzer ( PC Please, do not for uncertainty mea	o IEC 60942:2003 entation of the piston th the cavity up thod used to measure hnique erence measurement er 4180 ue of the correction a e corresponding to th 0 = 0,08 dB cc environmental cor thod used to measure + software ARTA) reget to submit your fir surement" shall be us	phone during the operated sources of the generated sources of the gener	alibration? Was it und pressure level e use? Did you use ured sound pressu e? ion + noise? Did you get. The ISO docu re document.	horizontal? Was it vertical with the cav Point of the microphone method is a LS2P or another one? In level: In use a rejection filter device (distortion ment "Evaluation of measurement data	ity up? Was it vertical with the cavity (insert voltage technique) or another (insert voltage technique) or
No with respect t What was the ori down? Was it vertical wi What was the me one? Insert voltage tec What was the ref LS2P Bruel & Kjae What was the ref LS2P Bruel & Kjaer 418 b) for the referen -1,212 dB What was the me FFT analyzer ( PC Please, do not for uncertainty mea Do you have any a	o IEC 60942:2003 entation of the piston th the cavity up thod used to measure hnique erence measurement er 4180 ue of the correction a e corresponding to th i0 = 0,08 dB cce environmental cor thod used to measure + software ARTA) reget to submit your fir surement" shall be us additional informatio	phone during the operated sources of the generated sources of the gener	alibration? Was it und pressure level e use? Did you use ured sound pressu ? ion + noise? Did you get. The ISO docu e document. ke to share to the	horizontal? Was it vertical with the cav horizontal? Was it vertical with the cav ? Did you use the microphone method i d a LS2P or another one? ure level: bu use a rejection filter device (distortion ment "Evaluation of measurement data pilot laboratory?	ity up? Was it vertical with the cavity (insert voltage technique) or another (insert voltage technique) or

	Artefa	ct: Pistonphone m	nanufactured by Brü	el and Kjaer, type 4228, serial number 2	2836183
		Results obtained	d using an <mark>one-inch</mark>	reference measurement microphone	
National Metrology Institute LACOMET			COMET		
Period of the calibration Air temperature (°C)		Static pressure (kPa)	Relative humidity (%)		
April 8 to April 19, 2019 22.1		88.1	52		
Sound pressure l	evel. dB re. 20 µPa (c	orrected for load	volume correspond	ing to the microphone used and for the	e reference environmental condition
oound pressure i	Detern	nined	rename correspond	Uncertai	inty (k = 2)
	123.	899		0	.17
P.S.: The determir	ned SPL should be rep	oorted with three	decimals. The pilot	laboratory will round it for two decima	ls.
Frequ	ency, Hz	Total harmor	nic distortion, %	Total distortion + noise, % (measured	over a bandwidth of 22.4 Hz to 22.4 k
Measured	uncertainty (k = 2)	Measured	Uncertainty (k = 2	) Measured	Uncertainty (k = 2)
2.31.1/4	0.05	0.303	0.2	0.700	0.4
Are there any dev No with respect to What was the orie	iations from IEC 6094. b IEC 60942:2003 ntation of the piston	2:2017 (Periodic to phone during the	ests) in the technica calibration? Was it	al procedure used? horizontal? Was it vertical with the cav	ity up? Was it vertical with the cavity
Are there any dev No with respect to What was the orie down? Was it vertical wit	iations from IEC 6094 DEC 60942:2003 Intation of the piston h the cavity up	2:2017 (Periodic tr	ests) in the technica calibration? Was it	al procedure used? horizontal? Was it vertical with the cav	ity up? Was it vertical with the cavity
Are there any dev No with respect to What was the orie down? Was it vertical wit What was the met one?	iations from IEC 6094 o IEC 60942:2003 Intation of the piston h the cavity up	2:2017 (Periodic to phone during the the generated so	ests) in the technica calibration? Was it pund pressure level	al procedure used? horizontal? Was it vertical with the cav ? Did you use the microphone method	ity up? Was it vertical with the cavity (insert voltage technique) or anothe
Are there any dev No with respect to What was the orie down? Was it vertical wit What was the met one? Insert voltage tech	iations from IEC 6094 IEC 60942:2003 Intation of the piston h the cavity up thod used to measure	2:2017 (Periodic to phone during the the generated so	ests) in the technica calibration? Was it pund pressure level	al procedure used? horizontal? Was it vertical with the cav ? Did you use the microphone method	ity up? Was it vertical with the cavity (insert voltage technique) or anothe
Are there any dev No with respect to What was the orie down? Was it vertical wit What was the met one? Insert voltage teck What was the refe	iations from IEC 6094: IEC 60942:2003 Intation of the piston h the cavity up thod used to measure nnique rence measurement	2:2017 (Periodic to phone during the the generated so microphone's typ	ests) in the technica calibration? Was it ound pressure level pe used? Did you us	al procedure used? horizontal? Was it vertical with the cav ? Did you use the microphone method e a LS1P or another one?	ity up? Was it vertical with the cavity (insert voltage technique) or anothe
Are there any dev No with respect to What was the orie down? Was it vertical wit What was the met one? Insert voltage tech What was the refe LS1P Bruel & Kjaer	iations from IEC 6094 o IEC 60942:2003 intation of the piston h the cavity up chod used to measure nnique inrence measurement 4160	2:2017 (Periodic to phone during the the generated so microphone's typ	ests) in the technica calibration? Was it pound pressure level be used? Did you us	al procedure used? horizontal? Was it vertical with the cav ? Did you use the microphone method e a LS1P or another one?	ity up? Was it vertical with the cavity (insert voltage technique) or anothe
Are there any dev No with respect to What was the orie down? Was it vertical wit What was the met one? Insert voltage tech What was the refe LS1P Bruel & Kjaer What was the valu	iations from IEC 6094 D IEC 60942:2003 Intation of the piston h the cavity up thod used to measure nnique erence measurement 4160 ie of the correction aj corresponding to the	2:2017 (Periodic to phone during the e the generated so microphone's typ pplied to the mea	ests) in the technica calibration? Was it ound pressure level be used? Did you us isured sound pressu	al procedure used? horizontal? Was it vertical with the cav ? Did you use the microphone method e a LS1P or another one? 	ity up? Was it vertical with the cavity (insert voltage technique) or anothe
Are there any dev No with respect to What was the orie down? Was it vertical wit What was the met one? Insert voltage tech What was the refe LS1P Bruel & Kjaer What was the valu a) for load volume Bruel & Kjaer 4160	iations from IEC 6094 D IEC 60942:2003 Intation of the piston h the cavity up chod used to measure nnique erence measurement 4160 ue of the correction al c corresponding to the = 0,28 dB	2:2017 (Periodic to phone during the e the generated so microphone's typ pplied to the mea e used microphon	ests) in the technica calibration? Was it bund pressure level be used? Did you us isured sound pressu	al procedure used? horizontal? Was it vertical with the cav ? Did you use the microphone method e a LS1P or another one? ire level:	ity up? Was it vertical with the cavity (insert voltage technique) or anothe
Are there any dev No with respect to What was the orie down? Was it vertical wit What was the met one? Insert voltage tech What was the refe LS1P Bruel & Kjaer What was the valu a) for load volume b) for the referen	iations from IEC 6094 o IEC 60942:2003 intation of the piston h the cavity up chod used to measure intique rence measurement 4160 ie of the correction aj corresponding to thh i= 0,28 dB ce environmental cor	2:2017 (Periodic to phone during the the generated so microphone's typ pplied to the mea e used microphon nditions?	ests) in the technica calibration? Was it bound pressure level be used? Did you us isured sound pressu	al procedure used? horizontal? Was it vertical with the cav ? Did you use the microphone method e a LS1P or another one? ire level:	ity up? Was it vertical with the cavity (insert voltage technique) or anothe
Are there any dev No with respect to What was the orie down? Was it vertical wit What was the met one? Insert voltage tech What was the refe IS1P Bruel & Kjaer What was the valu a) for load volume Bruel & Kjaer 4160 b) for the referent -1,212 dB	iations from IEC 6094 D IEC 60942:2003 Intation of the piston h the cavity up thod used to measure anique erence measurement 4160 is of the correction al corresponding to the = 0,28 dB convincemental correction	2:2017 (Periodic to phone during the e the generated so microphone's typ pplied to the mea e used microphon nditions?	ests) in the technica calibration? Was it bund pressure level be used? Did you us isured sound pressu	al procedure used? horizontal? Was it vertical with the cav ? Did you use the microphone method e a LS1P or another one? ire level:	ity up? Was it vertical with the cavity (insert voltage technique) or anothe
Are there any dev No with respect to What was the orie down? Was it vertical wit What was the met one? Insert voltage tech What was the refe LS1P Bruel & Kjaer What was the valu a) for load volume Bruel & Kjaer 4160 b) for the referen -1,212 dB What was the met	iations from IEC 6094 o IEC 60942:2003 intation of the piston h the cavity up thod used to measure annique erence measurement e of the correction aj corresponding to the i = 0,28 dB co environmental correction thod used to measure	2:2017 (Periodic to phone during the e the generated so microphone's typ pplied to the mea e used microphon aditions?	ests) in the technica calibration? Was it bund pressure level be used? Did you us isured sound pressu ise? tion + noise? Did you	al procedure used? horizontal? Was it vertical with the cav ? Did you use the microphone method e a LS1P or another one? ire level:	ity up? Was it vertical with the cavity (insert voltage technique) or anothe n factor meter) or a FFT analyzer?
Are there any dev No with respect to What was the orie down? Was it vertical wit What was the met one? Insert voltage tecl What was the refe LS1P Bruel & Kjaer What was the valu a) for load volume Bruel & Kjaer 4160 b) for the reference -1,212 dB What was the met FFT analyzer	iations from IEC 6094 o IEC 60942:2003 intation of the piston h the cavity up thod used to measure nnique irrence measurement 4160 ie of the correction aj corresponding to thi = 0,28 dB ce environmental cor	2:2017 (Periodic to phone during the e the generated so microphone's typ pplied to the mea e used microphor nditions?	ests) in the technica calibration? Was it bund pressure level be used? Did you us isured sound pressu isured sound pressu isored sound pressu tion + noise? Did you	al procedure used? horizontal? Was it vertical with the cav ? Did you use the microphone method e a LS1P or another one? ire level:	ity up? Was it vertical with the cavity (insert voltage technique) or anothe n factor meter) or a FFT analyzer?
Are there any dev No with respect to What was the orie down? Was it vertical wit What was the met one? Insert voltage tech What was the refe LS1P Bruel & Kjaer What was the valu a) for load volum6 Bruel & Kjaer 4 Di for ke referent -1,212 dB What was the met FFT analyzer Please, do not for	iations from IEC 6094 o IEC 60942:2003 intation of the piston h the cavity up thod used to measure minique rence measurement 4160 ue of the correction aj e corresponding to thi = 0,28 dB ce environmental cor	2:2017 (Periodic to phone during the e the generated so microphone's typ pplied to the mea e used microphon aditions?	ests) in the technica calibration? Was it bound pressure level be used? Did you us isured sound pressu isured sound pressu tion + noise? Did yo dget. The ISO docu	al procedure used? horizontal? Was it vertical with the cav ? Did you use the microphone method e a LS1P or another one? ire level: u use a rejection filter device (distortic ment "Evaluation of measurement data	ity up? Was it vertical with the cavity (insert voltage technique) or another (insert voltage technique) or
Are there any dev No with respect to What was the orie down? Was it vertical wit What was the met one? Insert voltage tech What was the refe LS1P Bruel & Kjaer What was the valu a) for load volume Bruel & Kjaer 4160 b) for the referen -1,212 dB What was the met FFT analyzer Please, do not for uncertainty meas	iations from IEC 6094 o IEC 60942:2003 intation of the piston h the cavity up thod used to measure mique erence measurement 4160 is corresponding to the = 0,28 dB is environmental corr chod used to measure thod used to measure get to submit your fir surement" shall be us	2:2017 (Periodic to phone during the e the generated so microphone's typ pplied to the mea e used microphon nditions?	ests) in the technica calibration? Was it bound pressure level be used? Did you us isured sound pressu isured sound pressu isured sound pressu tion + noise? Did you dget. The ISO docu ce document.	al procedure used? horizontal? Was it vertical with the cav ? Did you use the microphone method e a LS1P or another one? ire level: u use a rejection filter device (distortion ment "Evaluation of measurement data	ity up? Was it vertical with the cavity (insert voltage technique) or anothe (insert voltage technique) or anothe in factor meter) or a FFT analyzer?
Are there any dev No with respect to What was the orie down? Was it vertical wit What was the met one? Insert voltage tech What was the refe IS1P Bruel & Kjaer What was the valu a) for load volume Bruel & Kjaer 4160 b) for the referent -1,212 dB What was the met FFT analyzer Please, do not for uncertainty meas	iations from IEC 6094 o IEC 60942:2003 intation of the piston h the cavity up thod used to measure anique erence measurement e 4160 is of the correction aj corresponding to the = 0,28 dB corresponding to the = 0,28 dB corresponding to the second to measure thod used to measure set to submit your fir surement" shall be us dditional information	2:2017 (Periodic to phone during the e the generated so microphone's typ pplied to the mea e used microphon ditions? ed the total distor	ests) in the technica calibration? Was it pund pressure level be used? Did you us isured sound pressu- isured sound pressu- tion + noise? Did you dget. The ISO docu cce document.	al procedure used? horizontal? Was it vertical with the cav ? Did you use the microphone method e a LS1P or another one? ure level: u use a rejection filter device (distortic ment "Evaluation of measurement data pilot laboratory?	ity up? Was it vertical with the cavity (insert voltage technique) or another (insert voltage technique) or another in factor meter) or a FFT analyzer?
Are there any dev No with respect to What was the orie down? Was it vertical wit What was the met one? Insert voltage tech What was the refe LS1P Bruel & Kjaer What was the valu a) for load volume Bruel & Kjaer 4160 b) for the referent -1,212 dB What was the met FFT analyzer Please, do not for, uncertainty meas Do you have any a The toroid seal of	iations from IEC 6094 o IEC 60942:2003 intation of the piston h the cavity up thod used to measure anique erence measurement e 4160 is of the correction aj corresponding to the e of the correction aj correction aj correction aj correction correction aj correction aj correction aj correction correction aj correction aj	2:2017 (Periodic to phone during the e the generated so microphone's typ pplied to the mea e used microphon aditions? ed the total distor real uncertainty bu sed as the referen n that you would I to 1/2" presented	ests) in the technica calibration? Was it bund pressure level be used? Did you us isured sound pressu- isured sound pressu- tion + noise? Did you dget. The ISO docu ce document. like to share to the j a noticeable wear,	al procedure used? horizontal? Was it vertical with the cav ? Did you use the microphone method e a LS1P or another one? ire level: ire level: in use a rejection filter device (distortic ment "Evaluation of measurement data pilot laboratory? so I added a counterweight of 87,8 g to a 1"picrobane and its preamplifier	ity up? Was it vertical with the cavity (insert voltage technique) or anothe (infactor meter) or a FFT analyzer? - Guide to the expression of the set 1/2"microphone set

# **B.7 INACAL**

Original results reported by INACAL.

Results obtained with the one-inch to half-inch adaptor type DP 0776, i.e. using a half-inch reference measurement microp         National Metrology Institute       INACAL         Period of the calibration       Air temperature (°C)       Static pressure (kPa)       Relative hu         1 week       24,1       995,4       54,         Sound pressure level, dB re. 20 µPa (corrected for load volume corresponding to the microphone used and for the reference environm       Determined       Uncertainty (k = 2)         124,083       0,107         P.S.: The determined SPL should be reported with three decimals. The pilot laboratory will round it for two decimals.       Image: Corrected Vincertainty (k = 2)         Frequency, Hz       Total harmonic distortion,%       Fotal distortion + noise,% (measured over a bandwidth of 7         Measured       Uncertainty (k = 2)       Measured       Uncertainty         251,176       0,005       0,161       0,030          P.S.: The measured frequency, THD and TD+N should be reported with one decimal extra than their respective uncertainty. The pilot lab them for the same decimals number of the uncertainty.          Are there any deviations from IEC 60942:2017 (Periodic tests) in the technical procedure used?       Image: Corrected vertical with the cavity up? Was it vertical own?         What was the orientation of the pistonphone during the calibration? Was it horizontal? Was it vertical with the cavity up? Was it ver	22.4 Hz to 22.4 ki ty (%) 22.4 Hz to 22.4 ki ty (k = 2) 
National Metrology Institute       INACAL         Period of the calibration       Air temperature (°C)       Static pressure (kPa)       Relative hu         1 week       24,1       995,4       54,         Sound pressure level, dB re. 20 μPa (corrected for load volume corresponding to the microphone used and for the reference environm       Determined       Uncertainty (k = 2)         24,083       0,107       0,107       P.S.: The determined SPL should be reported with three decimals. The pilot laboratory will round it for two decimals.         Frequency, Hz       Total harmonic distortion,%       Total distortion + noise,% (measured over a bandwidth of <i>i</i> Measured       Uncertainty (k = 2)       Measured       Uncertainty         25,176       0,005       0,161       0,030           P.S.: The measured frequency, THD and TD+N should be reported with one decimal extra than their respective uncertainty. The pilot lab them for the same decimals number of the uncertainty.           Are there any deviations from IEC 60942:2017 (Periodic tests) in the technical procedure used?           The method of comparison was used.            Mhat was the orientation of the pistonphone during the calibration? Was it horizontal? Was it vertical with the cavity up? Was it vertical own?	midity (%) .5 
Period of the calibration       Air temperature (°C)       Static pressure (kPa)       Relative hu         1 week       24,1       995,4       54,         Sound pressure level, dB re. 20 µPa (corrected for load volume corresponding to the microphone used and for the reference environm       Determined       Uncertainty (k = 2)         124,083       0,107         P.S.: The determined SPL should be reported with three decimals. The pilot laboratory will round it for two decimals.       Image: Corrected Vincertainty (k = 2)         Frequency, Hz       Total harmonic distortion,%       Fotal distortion + noise,% (measured over a bandwidth of 7)         Measured       Uncertainty (k = 2)       Measured       Uncertainty (k = 2)         P.S.: The measured frequency, Hz       Total harmonic distortion,%       Fotal distortion + noise,% (measured over a bandwidth of 7)         Measured       Uncertainty (k = 2)       Measured       Uncertainty         P.S.: The measured frequency, THD and TD+N should be reported with one decimal extra than their respective uncertainty. The pilot lab them for the same decimals number of the uncertainty.          Are there any deviations from IEC 60942:2017 (Periodic tests) in the technical procedure used?       Image: Corrected vertical vertical with the cavity up? Was it vertical own?         What was the orientation of the pistonphone during the calibration? Was it horizontal? Was it vertical with the cavity up? Was it vertical own?       Image: Corrected vert	midity (%) 5 hental condition 22.4 Hz to 22.4 ki ty (k = 2)  oratory will rou
1 week       24,1       995,4       54,         Sound pressure level, dB re. 20 µPa (corrected for load volume corresponding to the microphone used and for the reference environm Determined       Uncertainty (k = 2)         124,083       0,107         P.S.: The determined SPL should be reported with three decimals. The pilot laboratory will round it for two decimals.         Frequency, Hz       Total harmonic distortion,%         Yeasured       Uncertainty (k = 2)         Measured       0,030             P.S.: The measured frequency, THD and TD+N should be reported with one decimal extra than their respective uncertainty. The pilot lab them for the same decimals number of the uncertainty.         Are there any deviations from IEC 60942:2017 (Periodic tests) in the technical procedure used?         The method of comparison was used.         Mhat was the orientation of the pistonphone during the calibration? Was it horizontal? Was it vertical with the cavity up? Was it vertical town?         The instrument was oriented vertically with the c	5 22.4 Hz to 22.4 ki 22.4 Hz to 22.4 ki 24.4 Kz 20 
Sound pressure level, dB re. 20 μPa (corrected for load volume corresponding to the microphone used and for the reference environm         Determined       Uncertainty (k = 2)         124,083       0,107         P.S.: The determined SPL should be reported with three decimals. The pilot laboratory will round it for two decimals.         Frequency, Hz       Total harmonic distortion, %         Total harmonic distortion, %       Total distortion + noise, % (measured over a bandwidth of 251,176         0,005       0,161       0,030         251,176       0,005       0,161         P.S.: The measured frequency, THD and TD+H should be reported with one decimal extra than their respective uncertainty. The pilot lab them for the same decimals number of the uncertainty.         P.S.: The measured frequency for IEC 60942:2017 (Periodic tests) in the technical procedure used?         The method of comparison was used.         What was the orientation of the pistonphone during the calibration? Was it horizontal? Was it vertical with the cavity up? Was it vertical form?         The instrument was oriented vertically with the cavity up.	22.4 Hz to 22.4 kt ty (k = 2)  oratory will rou
Source Level, but P. 20, Uncertainty (k = 2)       Uncertainty (k = 2)         124,083       0,107         P. S.: The determined SPL should be reported with three decimals. The pilot laboratory will round it for two decimals.       Incertainty (k = 2)         Frequency, Hz       Total harmonic distortion, %       Fotal distortion + noise, % (measured over a bandwidth of 2         Measured       Uncertainty (k = 2)       Measured       Uncertainty (k = 2)         P. S.: The measured       Uncertainty (k = 2)       Measured       Uncertainty         P. S.: The measured frequency, THD and TD+N should be reported with one decimal extra than their respective uncertainty. The pilot lab them for the same decimals number of the uncertainty.       Image: State	22.4 Hz to 22.4 ki ty (k = 2)  toratory will rou
124,083       0,107         P.S.: The determined SPL should be reported with three decimals. The pilot laboratory will round it for two decimals.         Frequency, Hz       Total harmonic distortion,%       rotal distortion + noise,% (measured over a bandwidth of .         Measured       Uncertainty (k = 2)       Measured       Uncertainty (k = 2)         Measured       Uncertainty (k = 2)       Measured       Uncertaint (k = 2)         P.S.: The measured frequency, THD and TD+N should be reported with one decimal extra than their respective uncertainty. The pilot lab them for the same decimals number of the uncertainty.          Are there any deviations from IEC 60942:2017 (Periodic tests) in the technical procedure used?       If method of comparison was used.         What was the orientation of the pistonphone during the calibration? Was it horizontal? Was it vertical with the cavity up? Was it vertical jown?       If he instrument was oriented vertically with the cavity up.	22.4 Hz to 22.4 kl ty (k = 2)  boratory will rou
P.S.: The determined SPL should be reported with three decimals. The pilot laboratory will round it for two decimals.         Frequency, Hz       Total harmonic distortion, %       rotal distortion + noise, % (measured over a bandwidth of, Measured         Measured       Uncertainty (k = 2)       Measured       Uncertainty (k = 2)         Measured       0,005       0,161       0,030          P.S.: The measured frequency, THD and TD+N should be reported with one decimal extra than their respective uncertainty. The pilot lab them for the same decimals number of the uncertainty.          Are there any deviations from IEC 60942:2017 (Periodic tests) in the technical procedure used?       If he method of comparison was used.         What was the orientation of the pistonphone during the calibration? Was it horizontal? Was it vertical with the cavity up? Was it vertical own?       If he instrument was oriented vertically with the cavity up.	22.4 Hz to 22.4 ki ty (k = 2)  oratory will rou
Frequency, Hz       Total harmonic distortion, %       Fotal distortion + noise, % (measured over a bandwidth of ;         Measured       Uncertainty (k = 2)       Measured       Uncertainty (k = 2)       Measured       Uncertainty (k = 2)         251,176       0,005       0,161       0,030           P.S.: The measured frequency, THD and TD+N should be reported with one decimal extra than their respective uncertainty. The pilot lab them for the same decimals number of the uncertainty.           Yre there any deviations from IEC 60942:2017 (Periodic tests) in the technical procedure used?           What was the orientation of the pistonphone during the calibration? Was it horizontal? Was it vertical with the cavity up? Was it vertical town?           The instrument was oriented vertically with the cavity up.	22.4 Hz to 22.4 kl ty (k = 2)  poratory will rou
Measured       Uncertainty (k = 2)       Measured       Uncertainty       Measured	rty (k = 2)  ooratory will rou
251,176       0,005       0,161       0,030           P.S.: The measured frequency, THD and TD+N should be reported with one decimal extra than their respective uncertainty. The pilot lab them for the same decimals number of the uncertainty.	 poratory will rou
P.S.: The measured frequency, THD and TD+N should be reported with one decimal extra than their respective uncertainty. The pilot lab them for the same decimals number of the uncertainty. Are there any deviations from IEC 60942:2017 (Periodic tests) in the technical procedure used? The method of comparison was used. What was the orientation of the pistonphone during the calibration? Was it horizontal? Was it vertical with the cavity up? Was it vertica down? The instrument was oriented vertically with the cavity up.	ooratory will rou
What was the method used to measure the generated sound pressure level? Did you use the microphone method (insert voltage techni one? The comparison method was used by measuring the signal generated by the pistonphone and the signal generated by the function gene in such a way to read the same values in the multimeter.	ique) or another erator,
What was the reference measurement microphone's type use? Did you used a LS2P or another one? The microphone used was of type LS2P.	
What was the value of the correction applied to the measured sound pressure level:	
a) for load volume corresponding to the used microphone?	
UJUBU GB b) for the reference environmental conditions?	
-0,149 dB	
What was the method used to measured the total distortion + noise? Did you use a rejection filter device (distortion factor meter) or a F	FFT analyzer?
Only measured THD, the method used was distortion factor meter.	
Please, do not forget to submit your final uncertainty budget. The ISO document "Evaluation of measurement data - Guide to the expre uncertainty measurement" shall be used as the reference document.	
	ession of
Do you have any additional information that you would like to share to the pilot laboratory?	ession of

# Revised results reported by INACAL.

Ros	istonphone manufactu	ıred by Brüel and H	(jaer, type 4228, sei	ial number 2836183, with its one-inc	h to half-inch adaptor type DP 0776	
nest	Its obtained with the	one-inch to half-ir	ich adaptor type DP	0776, i.e. using a half-inch reference	measurement microphone	
National Metrology Institute INACAL		]				
Period of the calibration Air temperature (°C)		Static pressure (kPa)	Relative humidity (%)			
1	1 week 23.1		995.5	63.5		
Sound pressure	evel, dB re, 20 µPa (o	orrected for load v	olume correspondi	ng to the microphone used and for t	he reference environmental condition	
	Determ	nined		Uncert	ainty (k = 2)	
	123.9	952			0.116	
P.S.: The determi	ned SPL should be rep	orted with three o	lecimals. The pilot l	aboratory will round it for two decim	als.	
Frequ	iency, Hz	Total harmon	c distortion, %	Total distortion + noise, % (measure	d over a bandwidth of 22.4 Hz to 22.4 k	
Measured	Uncertainty (k = 2)	Measured	Uncertainty (k = 2)	Measured	Uncertainty (k = 2)	
Are there any dev	viations from IEC 60942	2:2017 (Periodic te	sts) in the technica	procedure used?		
The method of co	mparison was used.					
What was the ori	optation of the niston	nhono during tho	alibration2 Was it	porizontal? Was it vortical with the s	with up? Was it vortical with the cavit	
down?	entation of the piston	phone during the		ionzontar: was it vertical with the ca	avity up: was it vertical with the cavit	
The instrument w	as oriented vertically	with the cavity un				
ine instrument i	as offented vertically	inter ence carrey up				
What was the me one?	thod used to measure	the generated so	und pressure level	Did you use the microphone metho	d (insert voltage technique) or anothe	
The comparison r	nethod was used by m	easuring the signa	I generated by the	pistonphone and the signal generate	d by the function generator,	
in such a way to r	ead the same values in	n the multimeter.				
What was the ref	erence measurement	microphone's type	e use? Did vou used	a LS2P or another one?		
The microphone	used was of type LS2P.		•			
The microphone used was of type LS2P.						
What was the val	e corresponding to the	e used microphone	?			
What was the val a) for load volum						
What was the val a) for load volum ( zero)		b) for the reference environmental conditions?				
What was the val a) for load volum ( zero) b) for the referen	ce environmental con	ditions?	rection errors are s	implified by environmental condition	ne )	
What was the val a) for load volum ( zero) b) for the referen '(The 4228 pi	ce environmental con stophone is used as a	ditions? pattern, so the cor	rection errors are s	implified by environmental condition	ns.)	
What was the val a) for load volum ( zero) b) for the referen '(The 4228 pi What was the me	ce environmental con stophone is used as a thod used to measure	ditions? pattern, so the cor ed the total distort	rection errors are s ion + noise? Did you	implified by environmental condition	ns.) ion factor meter) or a FFT analyzer?	
What was the val a) for load volum (zero) b) for the referer '(The 4228 pi What was the me Only measured T	ce environmental con stophone is used as a thod used to measure HD, the method used	ditions? pattern, so the cor ed the total distort was distortion fac	rection errors are s ion + noise? Did you tor meter.	implified by environmental condition	ns.) ion factor meter) or a FFT analyzer?	
What was the val a) for load volum (zero) b) for the referer '(The 4228 pi What was the me Only measured T Please, do not fo	ce environmental con stophone is used as a thod used to measure HD, the method used rget to submit your fin	ditions? pattern, so the cor ed the total distort was distortion fac	rection errors are s ion + noise? Did you tor meter. get. The ISO docum	implified by environmental condition I use a rejection filter device (distort nent "Evaluation of measurement da	ns.) ion factor meter) or a FFT analyzer? ta - Guide to the expression of	
What was the val a) for load volum (zero) b) for the referer (The 4228 pi What was the me Only measured T Please, do not fo uncertainty mea	ce environmental con stophone is used as a thod used to measure HD, the method used rget to submit your fin surement" shall be us	ditions? pattern, so the cor ed the total distort was distortion fac al uncertainty bud ed as the reference	rection errors are s ion + noise? Did you tor meter. get. The ISO docum e document.	implified by environmental condition u use a rejection filter device (distort nent "Evaluation of measurement da	ns.) ion factor meter) or a FFT analyzer? ta - Guide to the expression of	
What was the val a) for load volum (zero) b) for the referer '(The 4228 pi What was the me Only measured T Please, do not fo uncertainty mea Do you have any.	ce environmental con stophone is used as a thod used to measure HD, the method used rget to submit your fin surement" shall be us additional information	ditions? pattern, so the cor ed the total distort was distortion fac al uncertainty bud ed as the reference n that you would li	rection errors are s ion + noise? Did you tor meter. get. The ISO docun e document. ke to share to the p	implified by environmental condition a use a rejection filter device (distort nent "Evaluation of measurement da ilot laboratory?	ns.) ion factor meter) or a FFT analyzer? ta - Guide to the expression of	

# **APPENDIX C – UNCERTAINTY BUDGETS**

### C.1 INMETRO

### SPL - LS1P

Source of Uncertainty	Uncertainty contribuitions (dB)	wi .	
Source of oncertainty	250 Hz	•	
Calibration of microphone	0.0250	50	
Drift of microphone	0.0065	50	
Static pressure + Temp Mic&Pistonphone	0.0065	1000000	
Polarisation voltage of the microphone	0.0050	1000000	
Microphone volume	0.0115	1000000	
Gain (insert voltage technique)	0.0050	1000000	
Stability of the signal generator	0.0006	1000000	
Digital multimeter HP3458A	0.0050	50	
Rounding	0.0030	1000000	
Repeatability	0.0115	2	
Combined Uncertainty	0.0325		
veff	67		
Coverage factor, k	2.00		
Expanded Uncertainty	0.065		
Reported Expanded Uncertainty	0.07		

### SPL - LS2P

Source of Uncertainty	Uncertainty contribuitions (dB)		
Source of oncertainty	250 Hz	•	
Calibration of microphone	0.0250	50	
Drift of microphone	0.0181	50	
Static pressure + Temp Mic&Pistonphone	0.0065	1000000	
Polarisation voltage of the microphone	0.0050	1000000	
Microphone volume	0.0115	1000000	
Gain (insert voltage technique)	0.0050	1000000	
Stability of the signal generator	0.0006	1000000	
Digital multimeter HP3458A	0.0050	50	
Rounding	0.0030	1000000	
Repeatability	0.0058	2	
Combined Uncertainty	0.0353		
veff	147		
Coverage factor, k	1.98		
Expanded Uncertainty	0.070		
Reported Expanded Uncertainty	0.07		

# C.2 NRC

NRC uncertainty budget for Type 4228 sound calibrator with Type 4160 reference microphone

Component	Source	Estimated standard	Sensitivity	Uncertainty	Degrees
		uncertainty	coemolent	(dB)	freedom
Measurements					
V <sub>ins</sub>	Accuracy of insert	0.001 dB	1	0.0010	6
	voltage				
e(V <sub>ins</sub> )	Error in indication	0.0017 dB	1	0.0017	6
$\Delta L_{V1}$	Level difference	0.0173 dB	1	0.0173	185
$\Delta L_{rep}$	Repeatability of SPL	0.02 dB	1	0.0200	50
$\Delta L_{res}$	Resolution	0.0029 dB	1	0.0029	00
Т	Temperature	0.0289 ℃	$-(\delta_T + K_T)$	0.0001	50
Ps	Barometric pressure	0.01 kPa	- (δ <sub>Ps</sub> + 20 / (In(10). <i>Ps</i> ))	-0.0007	200
Н	Relative humidity	3.82 %RH	-К <sub>н</sub>	-0.0004	200
Sound calibrate	or				
Kτ	Temperature coefficient	0.0003 dB/ °C	T - 23	0.0006	50
$\Delta L_{Ps}$	Effect of barometric	negligible	1	negligible	200
	pressure				
K <sub>H</sub>	Relative humidity coefficient	negligible	H - 50	negligible	50
$\Delta L_{vol}$	Effect of load volume	0.0058 dB	1	0.0058	50
Reference micr	ophone				
M <sub>ref</sub>	Calibration of	0.025 dB	1	0.0250	100
	microphone				
$\Delta M_{du}$	Drift of reference	0.0102 dB	1	0.0102	50
	microphone	0.0102 02		0.0102	
$\Delta M_{df}$	Difference in	negligible	1	negligible	50
	frequency				
δτ	Temperature	0.0009 dB/ °C	T - 23	0.0018	12
	coefficient	0.0000	D 101.005	0.0000	10
0 <sub>Ps</sub>	Barometric pressure	0.0003	Ps = 101.325	0.0009	12
A.M.	COEIIICIENT	ab/kPa	1	0.0007	10
ΔIVI <sub>H</sub>	humidity	0.0007 aB	I	0.0007	12
$\Delta M_{pv}$	Polarizing voltage	0.0015 dB	1	0.0015	50
Combined stan	dard uncertainty			0.0385	280
Expanded unc	ertainty $(k = 2)$			0.08	

Component	Source	Estimated	Sensitivity	Uncertainty	Degrees
		standard	coefficient	contribution	of
		uncertainty		(dB)	freedom
Measurements					
Vins	Accuracy of insert	0.001 dB	1	0.0010	6
	voltage				
e(V <sub>ins</sub> )	Error in indication	0.0017 dB	1	0.0017	6
$\Delta L_{V1}$	Level difference	0.0173 dB	1	0.0173	185
$\Delta L_{rep}$	Repeatability of SPL	0.02 dB	1	0.0200	50
$\Delta L_{res}$	Resolution	0.0029 dB	1	0.0029	00
Т	Temperature	0.0289 ℃	$- (\delta_T + K_T)$	0.0001	50
Ps	Barometric pressure	0.01 kPa	$-(\delta_{Ps} + 20 / (\ln(10), Ps))$	-0.0007	200
Н	Relative humidity	3.82 %RH	<u></u>	-0.0004	200
Sound calibrate	or				
K <sub>T</sub>	Temperature	0.0003 dB/ °C	T - 23	0.0006	50
,	coefficient	0.0000 42. 0		0.0000	
$\Delta L_{Ps}$	Effect of barometric	nealiaible	1	nealiaible	200
	pressure				
K <sub>H</sub>	Relative humidity	negligible	H - 50	negligible	50
	coefficient				
$\Delta L_{vol}$	Effect of load volume	0.0058 dB	1	0.0058	50
Reference micr	ophone				
M <sub>ref</sub>	Calibration of	0.015 dB	1	0.0150	100
	reference				
	microphone				
$\Delta M_{du}$	Drift of reference	0.0102 dB	1	0.0102	50
	microphone				
$\Delta M_{df}$	Difference in	negligible	1	negligible	50
	frequency				
δτ	Temperature	0.0013 dB/ ℃	T - 23	0.0026	12
	coefficient				
δ <sub>Ps</sub>	Barometric pressure	0.0007	<i>Ps</i> – 101.325	0.0021	12
	coefficient	dB/kPa			
$\Delta M_H$	Effect of relative	0.0023 dB	1	0.0023	12
	humidity	0.0015.15			
$\Delta M_{pv}$	Polarizing voltage	0.0015 dB	1	0.0015	50
Combined stan	dard uncertainty			0.0331	269
Expanded unc	ertainty ( <i>k</i> = 2)			0.07	

NRC uncertainty budget for Type 4228 sound calibrator with Type 4180 reference microphone

# C.3 NIST

NIST Uncertainty Budget for Supplementary Comparison SIM.AUV.A-S2 Sound Pressure Level Output of Pistonphone with LS1P microphone

Source of Uncertainty	Туре	Standard Uncertainty (%)
Microphone sensitivity as determined by comparison	В	0.38
Microphone sensitivity drift	А	0.16
Microphone sensitivity due to environmental effects	В	0.21
Microphone sensitivity change with frequency	В	0.01
Oscillator voltage measurement	В	0.07
Barometric pressure	В	0.07
Voltage ratio measurement	В	0.07
Polarizing voltage drift	В	0.07
Microphone volume departure from nominal LS1P acoustical load volume	В	0.06
Departure from nominal acoustical load volume due to assembly of microphone with pistonphone	В	0.07
Estimate of combined standard uncertainty (%)		0.49
Estimate of expanded ( <i>k</i> =2) uncertainty (%)		0.98
Estimate of expanded ( <i>k</i> =2) uncertainty (dB)		0.09 dB

# NIST Uncertainty Budget for Supplementary Comparison SIM.AUV.A-S2

# Sound Pressure Level Output of Pistonphone with LS2aP microphone

Source of Uncertainty	Туре	Standard Uncertainty (%)
Microphone sensitivity as determined by reciprocity	В	0.21
Microphone sensitivity drift	A	0.16
Microphone sensitivity due to environmental effects	В	0.21
Microphone sensitivity change with frequency	В	0.01
Oscillator voltage measurement	В	0.07
Barometric pressure	В	0.07
Voltage ratio measurement	В	0.07
Polarizing voltage drift	В	0.07
Microphone volume departure from nominal LS2aP acoustical load volume	В	0.06
Departure from nominal acoustical load volume due to assembly of microphone with pistonphone and DP 0776 adapter	В	0.20
Estimate of combined standard uncertainty (%)		0.42
Estimate of expanded ( <i>k</i> =2) uncertainty (%)		0.84
Estimate of expanded ( <i>k</i> =2) uncertainty (dB)		0.07 dB

### C.4 CENAM

Comparación regional en calibración de pistófonos. SIM.AUV.A-S2.

Presupuesto de incertidumbre para istófonos con micrófonos tipo LS1P. Centro Nacional de Metrología. México.

Fuente de incertidumbre	Valor de la cantidad de entrada	Fuente de información	Incertidumbre original	Distribución	Incertidumbre estándar	Coeficiente de sensibilidad	Contribución [dB]	Grados de libertad
			Presión acústic	a a condiciones de	e medición			
		Análisis estadístico [V]	0.00003	A normal k = 1				
Tensión de salida del micrófono [mV]	1.4694	Certificado de calibración [V]	0.000086	B normal k = 2	0.06631	0.0059	1.53645E-07	6.48E+14
		Resolución del instrumento [V]	0.0000029	Rectangular k = 1				
Sensibilidad de la cadena de medición [mV/mV]	0.993888	Análisis estadístico [V/V]	0.000001	B normal k = 2	0.00050	-8.7393	1.88612E-05	100
Sensibilidad del micrófono a condiciones de referencia [dB re 1 V/Pa]	-26.84	Certificado de calibración [dB re 1 V/Pa]	0.0300	B normal k = 2	0.01500	-1.0000	0.000225	100
		Análisis estadístico [hPa]	0.0230929	A normal k = 1				
Presión estática [hPa]	1013.03	Certificado de calibración [hPa]	0.0105	B normal k = 2	0.0384300	0.0017	4.1683E-09	14.17331275
		Resolución del instrumento [hPa]	0.0289	Rectangular k = 1				
Factor de corrección por presión del micrófono [dB/hPa]	-0.00168	Certificado de calibración [dB/hPa]	0.00004	B normal k = 2	0.0000052	0.2225	1.09E-10	100
		Análisis estadístico [°C]	0.0202	A normal k = 1				
Temperatura [°C]	23.26	Certificado de calibración [°C]	0.0850	B normal k = 2	0.0874166	0.0025	4.77604E-08	96.4609123
		Resolución del instrumento 0.0029 [°C]		Rectangular k = 1				
Factor de correccion por temperatura del micrófono [dB/°C]	-0.0025	Certificado de calibración [dB/°C]	0.0000	B normal k = 2	0.0000016	-0.2550	1.59E-12	60
Incertidumbre estándar c	ombinada						0.015622639	116.8452416

Fuente de incertidumbre	Valor de la cantidad de entrada	Fuente de información	Incertidumbre original	Distribución	Incertidumbre estándar	Coeficiente de sensibilidad	Contribución [dB]	Grados de libertad	
			Volumen del aco	plamiento pistófon	io-micrófono				
Volumen efectivo del micrófono [cm^3]	0.668	Certificado de calibración [cm^3]	0.0084	B normal k = 2	0.0042	0.4555	3.73E-06	100	
Volumen geométrico del pistófono [cm^3]	18.24	Certificado de calibración [cm^3]	0.32	B normal k = 2	0.16	0.0153	6.01E-06	100	
Incertidumbre estándar c	ombinada						0.003122275	169.2474008	
			Corre	ección por presión	1				
		Análisis estadístico [hPa]	0.0231	A normal k = 1					
Presión estática [hPa]	1013.03	Certificado de calibración [hPa]	0.0105	B normal k = 2	0.0384	-0.0100	1.47686E-07	14.17331275	
		Resolución del instrumento [hPa]	0.0289	Rectangular k = 1					
Factor de corrección por presión del pistófono [dB/hPa]	0.01	Certificado de calibración [dB/hPa]	0.0001	B normal k = 2	0.0000	-2.0000	6.4E-09	100	
Incertidumbre estándar c	ombinada						0.000392538	14.20778856	
			Corrección por te	emperatura y hum	edad relativa				
		Análisis estadístico [%]	0.0606	A normal k = 1					
Humedad relativa [%]	42.53	Certificado de calibración [%]	0.3000	B normal k = 2	0.8023	-0.0001	8.78044E-09	108.29	
		Resolución del instrumento [%]	0.0029	Rectangular k = 1					
		Análisis estadístico [°C]	0.0202	A normal k = 1					
Temperatura [°C]	23.26	Certificado de calibración [°C]	0.085	B normal k = 2	0.0874	-0.0003	5.9502E-10	96.4609123	
		Resolución del instrumento [°C]	0.0029	Rectangular k = 1					
Incertidumbre estándar c	ombinada						9.6827E-05	122.8309338	
Nivel de presión ac	ústica del pis	stófono						123.92 dB	
Repetibilidad y repr	roducibilidad	del NPA a c	ondiciones de	referencia				0.0054	
Incertidumbre com	binada del ni	vel de presió	ón acústica a co	ondiciones de r	eferencia			0.017	
Grados efectivos d	e libertad							157.31	
t95.45%(neff) 2.									
Incertidumbre expa	indida del niv	el de presió	n acústica a co	ndiciones de re	eferencia			0.034	

### Comparación regional en calibración de pistófonos. SIM.AUV.A-S2.

Presupuesto de incertidumbre para pistófonos con micrófonos tipo LS2P. Centro Nacional de Metrología. México.

Fuente de incertidumbre	Valor de la cantidad de entrada	Fuente de información	Incertidumbre original	Distribución	Incertidumbre estándar	Coeficiente de sensibilidad	Contribución [dB]	Grados de libertad	
			Presión acústic	a a condiciones d	e medición				
		Análisis	0.0000	A normal					
		estadístico [V]	0.00000	k = 1					
Tensión de salida del	0.0005	Certificado de	0.0000004	B normal	0.04450		1 0 1 0 0 5 5 0 7	4.005.40	
[mV]	0.3625	calibración [V]	0.0000021	k = 2	0.01453	0.0240	1.21205E-07	1.30E+16	
		Resolución del	0.0000000	Rectangular					
		[V]	0.0000029	k = 1					
Sensibilidad de la	0.000.400	Análisis	0.000004	B normal	0.000.40	0.0005	4 000405 05	400	
[mV/mV]	0.983403	[V/V]	0.000001	k = 2	0.00049	-8.8320	1.88012E-05	100	
Sensibilidad del micrófono a condiciones	00.74	Certificado de	0.0500	B normal	0.00500	4 0000	0.000005	100	
de referencia [dB re 1 V/Pa]	-38.74	[dB re 1 V/Pa]	0.0500	k = 2	0.02500	-1.0000	0.000625	100	
		Análisis	0.0000000	A normal					
		[hPa]	0.0230929	k = 1					
Presión estática	1013.16	Certificado de	0.0405	B normal	0.020.4200	0.0050	2002445-00	44 47004075	
[hPa]		[hPa]	0.0105	k = 2	0.0364300	0.0052	3.99344E-08	14.17551275	
		Resolución del	0.0000	Rectangular					
		[hPa]	0.0289	k = 1					
Factor de corrección por	0.0050	Certificado de	0.00004	B normal	0.0000050	0.0005	4 005 40	100	
[dB/hPa]	-0.0052	[dB/hPa]	0.00004	k = 2	0.0000052	0.0885	1.09E-10	100	
		Análisis	0.0202	A normal					
		[°C]	0.0202	k = 1					
Temperatura	22.24	Certificado de	0.0050	B normal	0.0007000	0.0000	0.00075.00	0.440050000	
[°C]	23.21	[°C]	0.0850	k = 2	0.0227303	0.0020	2.00007E-09	0.440956829	
		Resolución del	0.0000	Rectangular					
		[°C]	0.0029	k = 1					
Factor de correccion por temperatura del	-0.002	Certificado de	0.0000	B normal	0.0000016	0.2050	1 505 12	60	
micrófono [dB/°C]	-0.002	[dB/°C]	0.0000	k = 2	0.000010	-0.2000	1.09E-12	00	
Incertidumbre estándar c	ombinada						0.025377638	106.0764926	

Fuente de incertidumbre	Valor de la cantidad de entrada	Fuente de información	Incertidumbre original	Distribución	Incertidumbre estándar	Coeficiente de sensibilidad	Contribución [dB]	Grados de libertad
			Volumen del aco	plamiento pistófon	o-micrófono			
Volumen efectivo del micrófono [cm^3]	0.0435	Certificado de calibración [cm^3]	0.0084	B normal k = 2	0.0042	0.4555	3.73E-06	100
Volumen geométrico del pistófono [cm^3]	15.4002	Certificado de calibración [cm^3]	0.32	B normal k = 2	0.16	0.0153	6.01E-06	100
Incertidumbre estándar c	ombinada						0.003122275	118.928087
			Corre	ección por presión	1			
		Análisis estadístico [hPa]	0.0231	A normal k = 1				
Presión estática [hPa]	1013.16	Certificado de calibración [hPa]	0.0105	B normal k = 2	0.0384	-0.0100	1.47686E-07	14.17331275
		Resolución del instrumento [hPa]	0.0289	Rectangular k = 1				
Factor de corrección por presión del pistófono [dB/hPa]	0.01	Certificado de calibración [dB/hPa]	0.0001	B normal k = 2	0.0000	-2.0000	6.4E-09	100
Incertidumbre estándar o	ombinada						0.000392538	14.17876861
			Corrección por te	emperatura y hume	edad relativa			
		Análisis estadístico [%]	0.0606	A normal k = 1				
Humedad relativa [%]	54.07	Certificado de calibración [%]	0.3000	B normal k = 2	0.8023	-0.0001	8.73125E-09	108.29
		Resolución del instrumento [%]	0.0029	Rectangular k = 1				
		Análisis estadístico [°C]	0.0202	A normal k = 1				
Temperatura [°C]	23.21	Certificado de calibración [°C]	0.085	B normal k = 2	0.0227	-0.0004	6.46633E-11	0.440956829
		Resolución del instrumento [°C]	0.0029	Rectangular k = 1				
Incertidumbre estándar c	ombinada						9.37865E-05	108.4392867
Nivel de presión ac	ústica del pis	stófono						123.93 dB
Repetibilidad y rep	roducibilidad	del NPA a c	ondiciones de	referencia				0.0255
Incertidumbre com	binada del ni	vel de presió	ón acústica a co	ondiciones de r	eferencia			0.036
Grados efectivos d	e libertad							436.14
t95.45%(neff)								2.025
Incertidumbre expa	indida del niv	/el de presió	n acústica a co	ndiciones de re	eferencia			0.073

### C.5 INTI

#### PLANILLA PARA EL CALCULO DE LA INCERTIDUMBRE DE CALIBRACION

Procedimiento: PEA08 LS1P	Calibración de	piston	ón por técni	ica de tensión in	sertada	(IEC6094	2/17)					
Fuente de incertidumbre	Símbolo	c <sup>(1)</sup>	Valor (±)	Distribución <sup>(2)</sup>	Factor	n <sup>(3)</sup>	U;	U1 <sup>2</sup>	W-S	Contribucion	es Multimetr	o HP34401
Sensibilidad del micrófono a 250 Hz		1	0,050	N	2,0	10000	0,325	0,000625	3,90625E-11	V (AC) 1 año	1,5	Vac
Deriva de sensibilidad del micrófono		1	0,020	N	2,0	10000	0,010	0,0001	1E-12			
Polarización del micrófono	2	1	0,002	R	1,7	10000	0,301	1,33333E-06	1,77778E-16	Rango	10	0,00375
Volumen frontal y equivalente	The second second	1	0,010	R	1,7	10000	0,306	3,33333E-05	1,11111E-13	Resolucion	0,00001	1,00001
Resolución del multímetro		1	0,0001	R	1,7	10000	0,000	2,5148E-09	6,32421E-22			
Exactitud del multimetro		1	0,033	R	1,7	10000	0,019	0,000352325	1,24133E-11			
Presión atmosférica	the management	1	0,001	N	2,0	10000	0,301	4,13493E-07	1,70976E-17			
Temperatura ambiente		1	0,002	R	1,7	10000	0,001	0,00000075	5,625E-17			
Factor de amplificacion		1	0,002	R	1,7	10000	0,001	1,33333E-06	1,77778E-16			
Humedad relativa ambiente		1	0,005	R	1,7	10000	0,003	8,33333E-06	6,94444E-15			
Error de redondeo		1	0,010	R	1,7	10000	0,006	3,33333E-05	1,11111E-13			
Estimación de incertidumbre tipo B, k=1	Uc			N (15)		25362	0,034					

Fuentes de incertidumbres tipo A, dB re 20 mPa	Contention and and		Can in the
Incertidumbre tipo A, distribucion NORMAL (dB)	Station and states of the		Sector Mark
Repetibilidad			0,311
Estimación de incertidumbre tipo A, k=1	4794291.3259		0,011
Incertidumbre total, dB re 20 mPa	A STATISTICS		
Tipo A, N(95%)	k	2,0	0,022
Tipo B, N(95%)	k	2,0	0,367
Incertidumbre total, k=2			0,370
Incertidumbre final , dB re 20 mPa			± 0,07



20log

0,0325

0,00009

2836183 - LS1P - PCA 124 - SIM AUV.A-S2

Coeficientes de Sensibilidad
 N: normal; R:rectangular
 Grados de libertad

#### PLANILLA PARA EL CALCULO DE LA INCERTIDUMBRE DE CALIBRACION Proceedimiento- PEAOR LS2P

Procedimiento: PEA08 LS2P	Calibración de	pistonf	ón por técni	ica de tensión ins	sertada	IEC6094	2/17)		
Fuente de incertidumbre	Símbolo	c <sup>(1)</sup>	Valor (±)	Distribución <sup>(2)</sup>	Factor	n <sup>(3)</sup>	U;	u, <sup>2</sup>	W-S
Sensibilidad del micrófono a 250 Hz	A CONTRACTOR OF THE	1	0,050	N	2,0	10000	0,025	0,000625	3,90625E-11
Deriva de sensibilidad del micrófono		1	0,020	N	2,0	10000	0,010	0,0001	1E-12
Polarización del micrófono		1	0,002	R	1,7	10000	0,001	1,33333E-06	1,77778E-16
Volumen frontal y equivalente		1	0,010	R	1,7	10000	0,006	3,33333E-05	1,11111E-13
Resolución del multímetro		1	0,0001	R	1,7	10000	0,000	2,5148E-09	6,32421E-22
Exactitud del multimetro		1	0,033	R	1,7	10000	0,019	0,000352325	1,24133E-11
Presión atmosférica		1	0,001	N	2,0	10000	0,001	4,13493E-07	1,70976E-17
Temperatura ambiente	1012/02-0	1	0,002	R	1,7	10000	0,001	0,00000075	5,625E-17
Factor de amplificacion	The section	1	0,002	R	1,7	10000	0,001	1,33333E-06	1,77778E-16
Humedad relativa ambiente	and the second second	1	0,005	R	1,7	10000	0,003	8,33333E-06	6,94444E-15
Error de redondeo		1	0,010	R	1,7	10000	0,006	3,33333E-05	1,11111E-13
Estimación de incertidumbre tipo B, k=1	Uc		-	N (15)	3	25362	0,034		

u, <sup>2</sup>	W-S	Contribucione	s Multimetr	o HP34401	
0,000625	3,90625E-11	V (AC) 1 año	1,5	Vac	20log
0,0001	1E-12				
1,33333E-06	1,77778E-16	Rango	10	0,00375	0,0325
3,33333E-05	1,11111E-13	Resolucion	0,00001	1,00001	0,00009
2,5148E-09	6,32421E-22				
0,000352325	1,24133E-11				
4,13493E-07	1,70976E-17				
0,00000075	5,625E-17				
1,33333E-06	1,77778E-16				

Fuentes de incertidumbres tipo A, dB re 20 mPa			
Incertidumbre tipo A, distribucion NORMAL (dB)		1000	
Repetibilidad			0,024
Estimación de incertidumbre tipo A, k=1	SUSS MINZUGE		0,024
Incertidumbre total, dB re 20 mPa	1.5.5 S. S. S. S. S.		
Tipo A, N(95%)	k	2,0	0,047
Tipo B, N(95%)	k	2,0	0,067
Incertidumbre total, k=2	IN HOT SE		0,082
Incertidumbre final , dB re 20 mPa	CALL SHOWNED		± 0.083



2836183 - LS2P - PCA 124 - SIM AUV.A-S2

(1) Coeficientes de Sensibilidad (2) N: normal; R:rectangular (3) Grados de libertad

### C.6 LACOMET

en el calibrador

Temperatura

Coeficiente de temperatura calibrador

Corrección debida a la humedad

relativa en el calibrador

### **INCERTIDUMBRE CALIBRADOR 4160 LACOMET**

Partiendo de (3b)	$SPL_{cr} = SPL_{cr}$	$L_{cm} - \Delta SPL_p - \Delta SPL_T$	$-\Delta SPL_{hr}$ -	$\Delta SPL_V$ (3)	b)					
donde acorde al fabricante del e	quipo:									
	$\Delta SPL_p = 20 \log p$	$\frac{P_a}{10(\frac{P_a}{1013 \ hPa})}$								
	$\Delta SPL_{hr} = \frac{1013 h}{P_a}$	$\Delta Pa = \Delta L + 0,0064$	ΔL (dB) =	-0,005	Esta corrección se obtie	ene de la Fig 3.4 de	el manual del equi	ро		
	$\Delta SPL_V = -20 \ lo$	$g_{10}(\frac{V_{carga} + 18,4 \ cm^3}{19,733 \ cm^3})$	NOTA: Pa	ra Mic B&K mode	elo 4180 = + 0,08 dB y pa	ara Mic B&K mode	elo 4160= + 0,28 d	В		
	$\Delta SPL_T = \delta T_c (T - $	$T_{rsf}$ )								
Tabla 4a. Incertidumbre de las magn	nitudes de entrada	condiciones ambientales y seg	ún manual Pistófo	no Tipo 4228						
Magnitud X <sub>i</sub>	Valor estimado	Incertidumbre estándar u(x <sub>i</sub> )	Distribución de	Valor estimado	Incertidumbre					
	xi		probabilidad	xi	estándar u(x <sub>i</sub> )					
Presión	Pa	u(P <sub>a</sub> )	Rectangular	88095	29					
Humedad relativa	hra	u(hr)	Rectangular	52,32	1,62					
Temperatura	Т	u(T)	Rectangular	22,13	0,20					
Corrección que se obtiene de la Fig 3.4 del manual	ΔL	u(ΔL)	Rectangular	-0,005	-0,0014					
Tabla 4b. Contribuciones a la incerti	dumbre de las cor	recciones según manual Pistófon	o Tipo 4228							
Magnitud X <sub>i</sub>	Valor estimado	Incertidumbre estándar u(x <sub>i</sub> )	Distribución de	Coeficiente de	Contribución a la	Valor estimado	Incertidumbre	Coeficiente de	Contribución a la	Contribución a la
	xi		probabilidad	sensibilidad c <sub>i</sub>	incertidumbre u <sub>i</sub> (y)	xi	estándar u(x <sub>i</sub> )	sensibilidad c <sub>i</sub>	incertidumbre	incertidumbre
									u <sub>i</sub> (y) (dB)	u <sub>i</sub> (y) (%)
Corrección debida a la presión en el calibrador	ΔSPL <sub>p</sub>	u(ΔSPL <sub>p</sub> )	Rectangular	(20 log <sub>10</sub> (e)/P <sub>a</sub>	(u(P <sub>a</sub> ))(20 log <sub>10</sub> (e)/P <sub>a</sub>	-1,2132	0,0029			
Corrección debida a la temperatura	ΔSPL <sub>T</sub>		Rectangular			0,0004	0,0002			

 $\delta T_c$ 

т

∆SPL<sub>hr</sub>

u(δT<sub>c</sub>)

u(T)

 $u(\Delta SPL_{hr}) = 101333 u(\Delta L)/P_a$ 

Rectangular

Rectangular

Rectangular

(to be continued)

0,001

0,001

0,00013

-0,000102025

-(T - T<sub>ref</sub>)

 $-\delta T_c$ 

101333 u(∆L)/P<sub>a</sub>

-(T - T<sub>ref</sub>) u(δT)

-δT<sub>c</sub>u(T)

101333 u(AL) / Pa

-0,0005

22,1318

0,0007

0,00014

0,2040

0,0017

0,868181818

-0,0005

	$SPL_{cr} = SPL$	$L_{cm} - \Delta SPL_p - \Delta SPL_T$	$-\Delta SPL_{hr}$ -	$\Delta SPL_V$ (3)	)			$dB = 20 \log_{10} \left($	$1 + \frac{\%}{100}$ (1)	$\% = 100 (10^{\frac{dB}{20}} - $	1) (2)
Tabla 4c. Contribuciones a la incertio	íabla 4c. Contribuciones a la incertidumbre combinada del nivel de presión acústica en condiciones de referencia										
Magnitud X <sub>i</sub>	Valor estimado	Incertidumbre estándar u(x <sub>i</sub> )	Distribución de	Coeficiente de	Contribución a la	Valor estimado	Incertidumbre	Coeficiente de	Contribución a la	Contribución a la	% contribución a
	×i		probabilidad	sensibilidad c <sub>i</sub>	incertidumbre u <sub>i</sub> (y)	xi	estándar u(x <sub>i</sub> )	sensibilidad c <sub>i</sub>	incertidumbre	incertidumbre	la incertidumbre
									u <sub>i</sub> (y) (dB)	u <sub>i</sub> (y) (%)	
Nivel de presión en condiciones de medida	SPL <sub>cm</sub>	u(SPL <sub>cm</sub> )	Normal	1	u(SPL <sub>cm</sub> )	122,9804	0,0339	1	0,03392	0,391	28,5
Corrección debida a la presión en el calibrador	∆SPL <sub>p</sub>	u(ΔSPL <sub>p</sub> )	Rectangular	-1	(-1) u(ΔSPL <sub>p</sub> )	-1,2132	0,0029	-1	-0,00286	0,033	2,4
Corrección debida a la temperatura en el calibrador	∆SPL <sub>T</sub>	u(ΔSPL <sub>T</sub> )	Rectangular	-1	(-1) u(ΔSPL <sub>T</sub> )	0,0004	0,0002	-1	-0,00016	0,002	0,1
Corrección debida a la humedad relativa del calibrador	∆SPL <sub>hr</sub>	u(ΔSPL <sub>hr</sub> )	Rectangular	-1	(-1) u(ΔSPL <sub>hr</sub> )	0,00065	0,0017	-1	-0,00166	0,019	1,4
Corrección debido al volumen de carga	$\Delta SPL_{v}$	u(ΔSPL <sub>v</sub> )	Rectangular	-1	(-1) u(ΔSPL <sub>v</sub> )	0,280	0,081	-1	-0,08083	0,926	67,5
								u(dB) =	0,0870		100,0
								U(dB) =	0,1739		

### INCERTIDUMBRE CALIBRADOR 4180 LACOMET

Partiendo de (3b)	$SPL_{cr} = SPL_{cr}$	$L_{cm} - \Delta SPL_p - \Delta SPL_T$	$-\Delta SPL_{hr}$ -	$\Delta SPL_V$ (3)	b)					
donde acorde al fabricante del e	quipo:									
	$\Delta SPL_p = 20 \log p$	$\frac{P_a}{10(\frac{P_a}{1013 hPa})}$								
	$\Delta SPL_{hr} = \frac{1013 h}{P_a}$	$\frac{Pa}{\Delta L} = 0,0064$	ΔL (dB) =	-0,005	Esta corrección se obtie	ene de la Fig 3.4 de	el manual del equi	ро		
	$\Delta SPL_V = -20 \ lo$	$g_{10}(\frac{V_{carga} + 18,4 \ cm^3}{19,733 \ cm^3})$	NOTA: Pa	ra Mic B&K mode						
	$\Delta SPL_T = \delta T_c (T -$	$T_{ref}$ )								
Tabla 4a. Incertidumbre de las magn	itudes de entrada	: condiciones ambientales y seg	ún manual Pistófo	no Tipo 4228						
Magnitud X <sub>i</sub>	Valor estimado	Incertidumbre estándar u(x <sub>i</sub> )	Distribución de	Valor estimado	Incertidumbre					
	xi		probabilidad	xi	estándar u(x <sub>i</sub> )					
Presión	Pa	u(P <sub>a</sub> )	Rectangular	88095	29					
Humedad relativa	hra	u(hr)	Rectangular	52,32	1,62					
Temperatura	т	u(T)	Rectangular	22,13	0,20					
Corrección que se obtiene de la Fig 3.4 del manual	ΔL	u(ΔL)	Rectangular	-0,005	-0,0014					
Tabla 4b. Contribuciones a la incerti	dumbre de las con	recciones según manual Pistófon	o Tipo 4228							
Magnitud X <sub>i</sub>	Valor estimado	Incertidumbre estándar u(x <sub>i</sub> )	Distribución de	Coeficiente de	Contribución a la	Valor estimado	Incertidumbre	Coeficiente de	Contribución a la incertidumbre	Contribución a la incertidumbre
	~			Scholbriddud q	incertitudinisi e u <sub>l</sub> (y)	<b>^</b>	cotandar a(x <sub>i</sub> )	occionanta da	u;(y) (dB)	u;(y) (%)
Corrección debida a la presión en el calibrador	ΔSPL <sub>p</sub>	u(ΔSPL <sub>p</sub> )	Rectangular	(20 log <sub>10</sub> (e)/P <sub>a</sub>	(u(P <sub>a</sub> ))(20 log <sub>10</sub> (e)/P <sub>a</sub>	-1,2132	0,0029			
Corrección debida a la temperatura en el calibrador	ΔSPL <sub>T</sub>		Rectangular			0,0004	0,0002			
Coeficiente de temperatura calibrador	δΤε	u(δT <sub>c</sub> )	Rectangular	-(T - T <sub>ref</sub> )	-(T - T <sub>ref</sub> ) u(δT)	-0,0005	0,00014	0,868181818	0,00013	0,001
Temperatura	Т	u(T)	Rectangular	-δT <sub>c</sub>	-δT <sub>c</sub> u(T)	22,1318	0,2040	-0,0005	-0,000102025	0,001
Corrección debida a la humedad relativa en el calibrador	ΔSPL <sub>hr</sub>	$u(\Delta SPL_{hr}) = 101333 u(\Delta L)/P_a$	Rectangular	101333 u(∆L)/P <sub>a</sub>	101333 u(ΔL) / P <sub>a</sub>	0,0007	0,0017			

	$SPL_{cr} = SPI$	$L_{cm} - \Delta SPL_p - \Delta SPL_T$	$-\Delta SPL_{hr}$ -	$\Delta SPL_V$ (3k	5)			$dB = 20 \log_{10} \left($	$1 + \frac{\%}{100}$ (1)	$\% = 100 (10^{\frac{dB}{20}} - 1)$	1) (2)
Tabla 4c. Contribuciones a la incertio		,									
Magnitud X <sub>i</sub>	Valor estimado	Incertidumbre estándar u(x <sub>i</sub> )	Distribución de	Coeficiente de	Contribución a la	Valor estimado	Incertidumbre	Coeficiente de	Contribución a la	Contribución a la	% contribución a
	xi		probabilidad	sensibilidad c <sub>i</sub>	incertidumbre u <sub>i</sub> (y)	xi	estándar u(x <sub>i</sub> )	sensibilidad c <sub>i</sub>	incertidumbre	incertidumbre	la incertidumbre
									u <sub>i</sub> (y) (dB)	u <sub>i</sub> (y) (%)	
Nivel de presión en condiciones de medida	SPL <sub>cm</sub>	u(SPL <sub>cm</sub> )	Normal	1	u(SPL <sub>cm</sub> )	122,7640	0,0185	1	0,01849	0,213	40,0
Corrección debida a la presión en el calibrador	∆SPL <sub>p</sub>	u(ΔSPL <sub>p</sub> )	Rectangular	-1	(-1) u(ΔSPL <sub>p</sub> )	-1,2132	0,0029	-1	-0,00286	0,033	6,2
Corrección debida a la temperatura en el calibrador	∆SPL <sub>T</sub>	u(ΔSPL <sub>T</sub> )	Rectangular	-1	(-1) u(ΔSPL <sub>T</sub> )	0,0004	0,0002	-1	-0,00016	0,002	0,3
Corrección debida a la humedad relativa del calibrador	ΔSPL <sub>hr</sub>	u(ΔSPL <sub>hr</sub> )	Rectangular	-1	(-1) u(ΔSPL <sub>hr</sub> )	0,00065	0,0017	-1	-0,00166	0,019	3,6
Corrección debido al volumen de carga	$\Delta SPL_{v}$	u(ΔSPL <sub>v</sub> )	Rectangular	-1	(-1) u(ΔSPL <sub>v</sub> )	0,080	0,023	-1	-0,02309	0,266	49,9
								u(dB) =	0,0297		100,0
						-1,212		U(dB) =	0,0594		

# C.7 INACAL

NPA nominal del calibrador:	124.0	dB		
Defense of a day local day in the local day				
Datos para el calculo de incertidumbre	)			
Pistofono				
Incertidumbre de calibracion	0.06	dB	Certifficado	o trazabilio
Parametra				
Incertidumbre de calibracion	0.3	hPa		
Resolucion	0.1	hPa		
Estabilidad	0.5	hPa		
Easter de correcion				
Pactor de Correctori	0.1	dB		
	0.1	uD		
Multimetro-pistofono				
Incertidumbre del certificado:	0.00010	V		
Resolucion al medir el pistofono:	0.00001	V		
Alcance al medir el pistofono:	10.00000	V		
Multimetro-calibrador				
Incertidumbre del certificado:	0.000028	V		
Resolucion al medir el calibrador:	0.000001	V		
Alcance al medir el calibrador:	1.000000	V		
Especificaciones del	0.0006			
multimetro al medir el pistofono:	0.0003			
Especificaciones del	0.0006			
Multimetro al medir el calibrador:	0.0003			
Microfono Distofono				
Incertidumbre del certificado:	0.05	dB		
incentionable del certificado.	0.05	ub .		
Microfono-Calibrador				
Incertidumbre del certificado:	0.05	dB		
Amplifandes Distofono				
AmplifiCador-Pistotono	0.040	dD		
incertidumbre dei certificado:	0.049	uD		
Amplificador-calibrador				
Incertidumbre del certificado:	0.049	dB		
Tabla del Calibrador				
Resolucion de la tabla:		dB		

Desviacion esta	andar	Calibracion	Calibracion	Resolucion	Estabilidad	Desviacion est	andar	Calibracion	Resolucion	Estabilidad	Certificado
del pistofono (V	/)	pistofono (dB)	multimetro (V)	mult-pisto (V)	multimetro (V)	del calibrador (	(∨)	multimetro (V)	mult-pisto (V)	multimetro (V)	micro-pisto (dB)
	0,00002	0,03	0,00005	0,0000029	0,0014	0,0	00003	0,00005	0,0000029	0,0005	0,025
Incertidumbre expandida en Porcentajes (%)											
	0,00051	0,346	0,00117	0,000070	0,034	0	,0021	0,0037	0,00022	0,042	0,288

Certificado	Certificado	Certificado	Desviacion	Certificado	Resolucion	Estabilidad	Factor correcion		Incertidumbre	Incertidumbre
micro-pisto (dB)	ampli-pisto (dB)	ampli-cali (dB)	Barometro (hpa)	Barometro (hPa)	Barometro(hPa)	Barometro (hPa)	de tabla calib	rador (dB)	Combinada (%)	Combinada (dB)
0,025	0,0245	0,0245	0,088	0,15	0,029	0,288675135		0,014		
0,288	0,282	0,282	0,009	0,015	0,003	0,029		0,166	1,381	0,12

# APPENDIX D – LACOMET COMMENTS ON THE UNCERTAINTY REPORTED FOR SOUND PRESSURE LEVEL

The note "b", presented under Table 3, informs that "Despite of the uncertainty of measurement exceeding the maximum-permitted value (± 0.10 dB) stated in IEC 60942:2017 [4], the measurement result was considered for comparisons purposes."

During the process of reviewing the draft A report, LACOMET provided additional information about its uncertainty report for sound pressure level using a LS1P microphone. The following explanation was given by LACOMET:

# "...in the TECHNICAL PROTOCOL SIM.AUV.A-S2 it was established that:

'Results shall be corrected for the load volume corresponding to the microphones used and for the reference environmental conditions specified in IEC 60942:2017 (air temperature: 23 °C, static pressure: 101,325 kPa and relative humidity: 50 % rh) [2] using the information presented in the pistonphone user manual [4]. The user manual will be circulated with the artefact to avoid the use of a different source of data by the participants.'

The corrections are given in table 3.1 of the user manual for the Bruel and Kjaer 4180 and 4160 microphones, but the manual does not give the uncertainty of such correction, so some criteria are required to estimate it, such as in the extreme case of, in the absence of information, using the same correction as uncertainty, a conservative criterion is to estimate the uncertainty from the correction treating it as a rectangular distribution (this was my case as you can confirm in the book of uncertainties sent, sheet '4. U cal cond. Reference, cell I32)', another option would be to use a fraction of the error to estimate uncertainty, but this criterion requires more information.

If equation (3.4) of the equipment manual is used, it is necessary to calculate the microphone front volume and the microphone equivalent volume, these data that are normally in the microphone calibration certificate or technical information of the manufacturer of this. In the case of the 1" microphone, it is possible since there is no adapter between the piston and the microphone equivalent volume is not enough since the middle is DP0776 adapter. In fact, the 'V<sub>load</sub> actual effective load volume' of the Bruel & Kajer 4180 microphone with the DP0776 adapter has a value of 1.14 cm<sup>3</sup>, information that is not given in the microphone calibration certificate or in the pistonphone manual, is a little hidden but it is there in the Instruction Manual Bruel & Kjaer BE0168-13, page 7.

The expanded uncertainty for the environmental reference conditions for the 1" microphone performing the calculations from equation (3.4) of the pistonphone user manual is 0.07 dB and the uncertainty expanded and reported using the criterion of a rectangular distribution for the correction given in table 3.1 of the pistonphone user manual calibrator is 0.17 dB."